ON THE CONSTRUCTION OF THE SECOND AVENUE LINE OF THE METROPOLITAN ELEVATED RAILWAY OF NEW YORK.*

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In presenting a paper upon the Construction of the Second Avenue Line of the Metropolitan Elevated Railway in New York, of which Mr. Wm. F. Shunk is Chief Engineer, the writer, who has been the Division Engineer in charge of the work, feels impelled to apologize to the members of the Society for its length and the recitation of numerous details, not easily avoided, however, in a comprehensive treatment of the subject. It has been written in the midst of the busy daily duties of professional labor.

DESCRIPTION OF THE ROUTE.

The line departs from the joint structure of the Metropolitan Elevated Railway and the New York Elevated Railroad at Chatham square, by curves of 230 and 250 feet radii for the up and down-town tracks respectively. Expressed metrically, with radii of 70.10 and 76.198 metres. The up-town track 55 deg. 30 ft. 45 in. and the down-town track 36 deg. 10 ft. 40 in. curvature; thence through Division street by tangent, excepting the up-town track, which has a reverse curve of 8 deg. 18 ft. total curvature and radius of 1,910 feet (582.157 m.), to form a parallel track; thence into Allen street by curves of 210 feet (64.007 m.), radii, with curvature of 63 deg. 03 ft.; thence through Allen street by tangent to Houston street; thence by curves of 1,910 feet (582.157 m.), radii and curvature of 7 deg. 41 ft. into First avenue; thence by tangent through First avenue to Twenty-third street; thence with a curvature of 90 deg. and radii respectively of 136 feet and 110 feet (41.452 and 33.527 m.), on the up and down-town tracks; thence by tangent through Twenty-third street to Second avenue, and into Second avenue by curves similar to those at First avenue and Twenty-third street, excepting that those of the up and down-town tracks of the former correspond respectively to those of the down and up-town tracks of the latter; thence by tangent through Second avenue to One Hundred and Twenty-ninth street or the Harlem river.

TABLE NO. 1.

TABLE OF LENGTHS OF TANGENTS AND CURVES.

LOCATION.	EAST TRACK.		WEST TRACK.	
	Feet.	Meters.	Feet.	Meters.
Chatham sq. Curves....	222.80	67.908	157.80	48.907
Division st. Tangent..	1,004.60	306.196	991.10	302.082
Allen street Curves....	231.12	70.444	231.12	70.444
Allen street Tangent..	3,206.67	977.375	3,209.61	978.271
Houston st. Curves....	256.10	78.058	256.10	78.058
First avenue Tangent..	5,448.38	1,660.636	5,438.56	1,657.625
First avenue Curves....	219.90	67.024	172.79	52.665
Twentythird st. Tangent	503.00	153.311	503.00	153.311
Second av. Curves....	172.79	52.665	219.90	67.024
Second av. Tangent..	27,942.00	8,516.566	27,939.00	8,515.651
Total lineal ft. and metres.....	39,207.36	11,950.183	39,118.92	11,923.228
Equals miles and kilometres....	7.42 miles	1.950 kil.m.	7.409 miles	11.923k.m.

The curves are but little more than two per cent. of the length of the whole line.

The successive steps in the construction of an elevated railway are not wholly different from those which occur in building on the surface, as will be seen by the following natural order to which we conformed, viz.:

1. Preliminary survey.
2. Location of "layout."
3. Construction of foundations.
4. Setting cast-iron bases for columns.
5. Erection of iron structure.
6. Track structure and track laying.
7. Painting.

PRELIMINARY SURVEY.

In order that no mistakes should be made in projecting a layout, or in the succeeding work of construction, this survey should be made, as it was, with the greatest care. The obstacles to the attainment of such a result in the crowded business streets of a city like New York are only known to engineers whose patience and good nature have similarly been taxed quite up to the limit of elasticity.

It may be surprising to some to learn that no errors greater than 1 in. per 1,000 ft. (.0254 m. per 304.795 m.) of horizontal measurement, and $\frac{5}{1000}$ of a foot per 1 ft. (.0016 m. per .305 m.), in elevation were allowed.

The first, and a very important step in the survey, was the adoption of a convenient base line that could be used until the final completion of the railway. It was located on the easterly sidewalks, far enough from the curb line to escape any possible interference from the excavations for piers. No small difficulty was experienced in locating these base lines, especially on the avenues, where they are from 1 to 5 miles long, the requirements being a straight line parallel to the axis of the street or avenue. There is no angle in the First avenue base line, but to overcome several irregularities in the Second avenue line, and to prevent encroachment with our columns on the horse-car tracks, a few slight angles of a few seconds each were permitted on the base line; these, where it was possible to do so, were located on summits of grades, and cannot be detected with the eye.

After permanently establishing the base lines, the longitudinal distance was measured with wooden rods 25 ft. (7.619 m.) in length, the measurement being guided by a transit man. These rods were made by Young, of Philadelphia, and pronounced by him to be accurate by the United States standard. Several auxiliary test standard lengths were first laid off at convenient points, where the rods were tested every morning for the day's measurement. Full stations were thus located and permanently marked every 100 ft. (30.479 m.), and sub-stations every 25 ft (7.619 m.). Following the measuring party was another small party, whose duty it was to locate all obstacles with steel tape from some of the full or sub-stations. It was found of the utmost importance in the subsequent projection of a layout, that all such prominent features as sewer basins, fire hydrants, man-holes, lamp posts, telegraph poles, sewer, gas, and water mains, curb lines, house lines, vaults, chimneys, horse-car tracks, and large, important and public buildings, should be accurately measured and mapped. A location for the columns was then decided upon, and spotted upon the map for construction or verification. The spacing and arrangement of the columns on the street or sidewalk to support the structure is called the "layout." After the columns had been marked off at their proper sites, elevations thereat were taken for the purpose of establishing grade and determining the length of the columns.

For the purposes of construction, bench marks were permanently established every two blocks, or about 500 ft. (152.396 m.) apart.

CONSTRUCTION OF FOUNDATIONS.

The requirements imposed by the Board of Commissioners of Rapid Transit in regard to foundations were:

1. The foundations, where necessary, shall be increased in area, so that in no case shall a weight greater than 2,000 lbs. to the square foot come upon any base (9765. kgs. per sq. m.).

2. Good hydraulic cement shall be used in the masonry, and Portland cement of the first quality shall be used in case the foundations are constructed of concrete. If bricks are use, they shall be hard burnt, and of the best quality.

No foundations were constructed of concrete; all the other requirements were rigidly adhered to. Their classification was as follows:

1. Standard street piers.
2. Standard sidewalk piers.
3. Special street piers.
4. Special sidewalk piers.

The Standard Street Pier was built in the driveway on firm ground where no obstacles were met. The pits were opened 9 ft. (2.743 m.) square, and excavated to a depth of 5 ft. 6 in. (1.676 m.) below the bottom of the base casting, which usually made the excavation about 7 ft. (2.133 m.) below the street surface. The bottom of the pit was then examined with a sounding rod, and, if found satisfactory, was leveled, and, where deemed expedient, compacted with rammers. The sides a foot (.305 m.) high from the bottom were then shaped and smoothed to inclose a bed of concrete 8 ft. (2.438 m.) square and 9 in. (.2287 m.) thick. The concrete was composed of broken stone, not exceeding 2½ in. (.0635 m.) in the largest dimension, four parts; clean, sharp sand, two parts; American hydraulic cement, one part. The cement and sand were first mixed with a minimum amount of water, after which the broken stone, being well wet, was added, the whole mixture being then thoroughly incorporated on a tight board platform, was deposited in one layer in the pit, and rammed till the soft material flushed to the surface; before setting, pockets were scooped in the surface of the concrete, which were partially filled with thin hydraulic mortar subsequently to receive the bolt washers and heads. On top of the concrete were laid two stones, averaging 5 in. (.127 m.) thickness and 3 ft. by 7 ft. (.914 m. by 2.13 m.) laid so as to offer a base of 7 ft. (2.13 m.) square. These large stones served the purpose of anchorage for the bolts, as well as support for the brick pier. Fig. 1 gives plan and elevation of standard street pier; fig. 2, standard sidewalk pier.

Standard Sidewalk Piers.—Pits for the piers were excavated 12 ft. (3.66 m.) deep. The concrete footing was 8 ft. 6 in. (2.59 m.) square, and 12 in. (.305 m.) thick, deposited in two layers. The height, from bottom of concrete to bottom of socket, in base casting, was 10 ft. 6 in. (3.2 m.).

The height from bottom of foundation stones to top of brickwork was 9 ft. 3 in. (2.82 m.); in all other respects the piers corresponded to the standard street piers previously described.

Special Street Piers were those which from natural or artificial causes could not be built to the standard plan. The reasons for departing from the regular form of construction were foundations in quicksand, muck, made ground, or other soft bottom, adjacent or underlying water and gas mains, sewers, with their appendages of man-holes, basins, culverts, etc.

Special Sidewalk Piers were those required when vaults or other subterranean obstacles were encountered.

The total number of piers built to date is 2,014, of which 1,496 are special. Of the latter number, 198 rest on piles. The total number of piles driven

EXHIBITS OF TESTS OF ROSENDALE CEMENT, USED ON SECOND AVENUE EXTENSION M. E. R.

BRAND OF CEMENT.	PROPORTION OF MIXTURE: TIME OF SETTING: BREAKAGE PER SQUARE INCH.												Temperature.		
	Neat.			Sand, 1; Cement 1.			Sand, 1½; Cement, 1.			Sand, 2; Cement, 1.					
	Time.	Breakage.		Time.	Breakage.		Time.	Breakage.		Time.	Breakage.		Air.	Water.	Fineness.
		Lbs. per sq. in.	Kg. per sq. c. m.		Lbs. per sq. in.	Kg. per sq. c. m.		Lbs. per sq. in.	Kg. per sq. c. m.		Lbs. per sq. in.	Kg. per sq. c. m.			
F. O. Norton	24 hrs.	44	3.09	24 hrs.	40	2.81	24 hrs.	40	2.81	48 hrs.	39	2.74			
"	"	50	3.52												
"	"	42	2.95												
"	"	58	4.08	"	58	4.08	"	48	3.38	"	40	2.81			
"	"	50	3.52												
"	"	65	4.57	48 hrs.	60	4.22	48 hrs.	50	3.52	"	45	3.17			
"	7 days.	80	5.63	7 days.	60	4.22	7 days.	40	2.81	7 days.	40	2.81			
"	2 mths.	360	25 32	2 mths.	220	15.47	2 mths.	189	13.29	2 mths.	174	12.24	Avg. tem. 75° F.	Avg. tem. 68° F.	96:100
"	5 "	560	39 38												
"	6 "	530	37.27												
Newark & Rosendale	24 hrs.	44	3.09												
"	"	46	3.24	24 hrs.	40	2.81	7 days.	49	3.45						
"	48 hrs.	42	2.95												
"	24 hrs.	38	2.67	"	36	2.53	"	52	3.66	2 mths.	114	8.02			
"	"	42	2.95	"	34	2.39									
"	"	45	3.17	"	32	2.25	1 mth.	175	12.31						
"	2 mths.	325	22.86							5 mths.	275	19.34	74° F.	70° F.	95:100
New York Cement Company	24 hrs.	42	2.95	24 hrs.	31	2.18	24 hrs.	36	2.53						
" "	48 hrs.	42	2.95												
" "	7 days.	62	4.36												
" "	24 hrs.	48	3.38												
" "	"	48	3.38	48 hrs.	58	2.67									
" "	"	50	3.52				24 hrs.	28	1.97	24 hrs.	30	2.11	74°	70°	
													72°	68°	91:100
Hoffman & Lawrenceville	24 hrs.	48	3.38							24 hrs.	32	2.25	74°	70°	
"	"	52	3.66												
"	"	42	2.95												
"	7 days.	68	4.78							7 days.	38	2.67	70°	67°	
Rocklock	24 hrs.	39	2.74												
"	"	58	4.08												
"	"	62	4.36				24 hrs.	38	2.67	7 days.	87	6.12	78°	70°	
"	"	47	3.31				7 days.	94	6.61				"	"	94:100

* From the Transactions of the American Society of Civil Engineers, Vol. X. April, 1881.

was 3,310; the average length driven was 20 ft. (6.1 m.). They were spruce, straight, straight-grained and smooth, free from large knots, divested of bark, not less than 12 in. (.305 m.) at the butt after sawing off, and 8 in. (.201 m.) at the small end. They were driven to hard bottom, or until the set did not exceed one-fourth of an inch (.0063 m.) under the blow of a ram weighing 1,200 lbs. (544.3 kg.), falling 8 ft. (2.44 m.). The piles were hooped for driving, and sawed off horizontally 1 ft. (.305 m.) below mean high tide level, their heads then being surrounded with concrete. The usual form of capping and flooring was used.

Elevations of four street piers and an isometrical drawing of one are given in figs. 3, 4, 5 and 6 as fair samples of the prominent obstructions encountered on First and Second avenues. The frequency of the obstacles met with is made apparent by the fact that 74.3 per cent. of the piers are special.

The materials for concrete and hydraulic mortar were compounded by actual measure, and all cement was subject to inspection and test before use. The specifications for cement required it to be capable of resisting a tensile strain of 50 lbs. to the square inch (3.52 kg. per square cm.) after thirty minutes exposure in air and 24 hours immersion in water. The results of some tests made by the inspector of sand and cement are given in Exhibit 1, and show results from cement obtained from five different manufacturers. Much good sand was obtained from the excavations at different points along the work. The remainder was delivered on scows from "Cow Bay," Long Island, or "The Kill," on Staten Island. The latter, although much more difficult to obtain, was by far the better sand; both kinds, however, were required to be "bank sand."

These mixtures and most of the tests (except the long time tests) were made during May, June, July and August, 1879, from the cement as received from the mills. A much larger number of tests, however, were made. From accepted brands only a portion have been selected for this tabulation, which are probably sufficient to show the strength of the Rosendale cement used on short and long time tests for tensile strength.

Since writing the bulk of this paper the writer had occasion to build some twenty piers to connect the Metropolitan Elevated Railway on Eighth avenue with the Harlem River Bridge. As the cost of materials and labor have largely increased since the construction of the Second avenue line, a epitome of this work is shown in Appendix I.

It may be of interest to note some experiments made by the writer to ascertain the amount of shrinkage in the materials combined to make the hydraulic mortar used. The measurements of the sand, cement and water were carefully made in a box containing exactly one cubic foot (28.3 litres). It was found that in the mixture, including the water that was used, there was a total shrinkage of 37 and 33⅓ per cent., respectively, for two different tests. Omitting the water in the deduction, it was found there was a shrinkage of 22½ and 25 per cent. in the dry materials, after being mixed into mortar for use.

The following table shows the proportions used:

TABLE No. 2.

QUANTITIES IN CUBIC FEET.

CEMENT.	SAND.	WATER.	MIXTURE.	MORTAR MADE.	REMARKS.
4	8	2¾	14¾	9 3-10	Exp. (1)
3	6	2	11	6¾	" (2)

QUANTITIES IN LITRES.

113.3	226.5	77.8	417.6	263.4	Exp. (1)
85	169.9	56.6	311.5	191.1	" (2)

From these results it would appear that for any known quantity of cement mortar required, 25 per cent of the amount should be added to the dry materials for shrinkage, the materials being used in the foregoing proportions.

The total number of bricks used in foundations, including the station piers built to date (Feb. 1, 1881), is 14,841,198, or an average of 7,8.9 per pier. The Haverstraw brick, as laid in these foundations, numbered by actual count from 19 to 21 per cubic foot (0.671 brick per litre), the variation being probably due to the thickness of joint.

CAST IRON BASE CASTINGS.

There were six patterns of base castings, used and designated as follows: A, AD, AE, B, BD and BE. The calibre of the first three patterns is 13½ in. (.343 m.) for Phœnix columns, whose cross section area ranges from 36 to 39 square inches (232.3 to 251.6 sq. c. m.).

The calibre of the remaining three patterns is 13¾ in. (.35 m.) for the same style of column, having a cross section area of 42 to 45 square inches (271 to 290 sq. c. m.). As the different patterns of the two calibres are essentially the same, only differing one-fourth of an inch (.0063 m.) in diameter, sketches of three patterns only are shown in fig. 7.

The base castings were delivered by the company on the curb line opposite the piers where they were to be set. The proper elevation, together with the lateral and longitudinal adjustment of the base, was given by the engineer in charge, who also directed how the work should be done. The restoration of the street surface was made in all cases acceptable to the city street authorities.

The following tables show the actual cost of material and labor for setting the base castings by days' work, where the pier had been built and street restored before the base casting was set:

TABLE 3.

FOR A AND B BASE CASTINGS.

	Time.	Cost.	
Time and cost of uncovering pier—2 men at 15 cents per hour	1⅓	.35	
Time and cost of moving base from sidewalk to pier—5 men at 15 cents per hour	⅓	.40	
Time and cost of erecting derrick and setting base casting—5 men at 15 cents per hour	4-5	.60	
Time and cost of repaving 25 square feet—2 men at 25 cents	1	.50	
Time and cost of washing, tarring and bricking—2 men at 25 cents	⅔	.35	
Time and cost of refilling—2 men at 15 cents	⅓	.15	
Time and cost of preparing cement mortar—1 man at 20 cents	⅓	.10	
Foreman and night watchman		.50	
Amount of cement used—¼ bbl. at $1		.25	
Amount of sand used—¼ bbl. at $1.25 per cubic yard		.05	
Number of bricks used—32 at $10 per M.		.32	
Amount of refuse carted away—⅓ cubic yard		.38	
Amount of sand for paving 2½ cubic feet		.11	
Amount of coal tar, cement wash, &c.		.10	
Oil for lamps, and incidentals		.05	1.26
Total cost			$4.21

TABLE NO. 4.

FOR AD, AE, BD, AND BE BASE CASTINGS.

	Time.	Cost.	
Time and cost of uncovering pier—2 men at 15 cents per hour	1¾	.50	
Time and cost of moving base from sidewalk to pier—5 men	¾	.60	
Time and cost of erecting derrick and setting base castings—5 men	1¼	.94	
Time and cost of repaving 40 square ft.—2 men at 25 cents per hour	1⅓	.75	
Time and cost of washing, tarring and bricking—2 men at 25 cents an hour	1	.50	
Time and cost of refilling—2 men at 15 cents per hour	¾	.23	
Time and cost of preparing cement—1 man at 20 cents per hour	¾	.15	
Foreman and night watchman		.63	4.30
Amount of cement used—½ bbl. at $1		.50	
Amount of sand used—⅛ bbl		.10	
Number of bricks used—60 at $10 per M.		.60	
Amount of refuse carted away—¾ cubic yard		.56	
Amount of sand for paving 4 cubic ft.		.18	
Amount of coal tar, cement wash, etc.		.15	
Oil for lamps, and incidentals		.05	2.14
Total cost			$6.44

Where the base setting followed the construction of the brick piers, it was found that thirty-five per cent. of the above cost was saved.

The base castings north of Eighty-seventh street were set the year following the pier construction, and done by contract at the following prices:

For A and B base castings, including all labor and materials, $3.75.

For AD, AE, BD and BE base castings, including all labor and materials, $5.25.

A saving of about eleven per cent. on the former, and about eighteen per cent. on the latter style of bases.

The average number set per day by days' work or by the company was ten, while the average number set per day by contractor was fifteen. It might be well to state, in this connection, that the contractor gave his undivided, personal attention to the work.

The following table shows the average weight of the different kinds of bases used, number of each pattern, and total weight of all in tons of 2,240 pounds and 1,000 kilograms:

TABLE NO. 5.

WEIGHTS OF CAST-IRON BASES.

No. used.	Pattern.	Average Weight. Lbs.	Kgs.	Total Weight. Tons of 2240 lbs.	Lbs.	Tons of 1000 kilograms.
1,463	A	3,204	1,453.32	2,092	1,316	2,126.21
49	A D	5,533	2,5 9.75	121	0,420	122.86
50	A E	6,026	2,733.37	134	0,840	136.67
409	B	3,205	1,454.78	585	0,854	594.00
24	B D	5,510	2,499.32	58	1,840	59.96
5	B E	6,048	2,743.35	13	1,300	13.72
2,000				3,005	4/100 tons.	3,054.16

The specifications for cast-iron column bases required them to be made of the best No. 2 Lehigh pig metal, or its equivalent in quality, three tons to one ton of machinery scrap.

The mixture was tested by taking a bar therefrom 1 in. (.0254 m.) square, and 1 ft. (.305 m.) between supports, which was required to sustain at its middle point one gross ton (1,016 kgs.), without fracture, the casting to be perfect in shape, the bolt-holes spaced exactly and cored square to the base. The cores for the barrels to be made without draught, and blackened to get a smooth casting; great care was necessary in adjusting the barrels, and the spherical bearing at the bottom of the socket was cast chilled. The casting was then permitted to cool slowly, remaining in the sand not less than twenty-four hours. The bases described, by their peculiar form of construction, were difficult to cast. The distribution of the metal in the barrel, bottom of socket, ribs and flanges, while well calculated to resist the incumbent strains upon them, necessitates great care in founding. The iron, in cooling, shrinks along the ribs, while the expansion, owing to the large amount of metal in the centre of the base, still continues at the bottom of the socket.

These reactionary forces sometimes caused a bursting of the base. Other reasons, also, combined to produce similar results, such as the use of too hard iron, pouring while too hot, cooling the casting too quickly, or moulding in damp sand, the latter tending to ruin the core by expansion of air or steam, or both, and thereby rendering the bottom of the socket too thin for use. The bases were subjected to a rigid inspection by striking with a sledge, measuring the various parts and scrutinizing with a critic's eye before leaving the foundry. The final act of setting the base in position was also a good test of its perfect construction. Not a few were rejected in the last act. The bases were set to a given elevation—an elevation of top of base being previously determined for the whole line, chiefly dependent upon the grade of the streets. A bed of hydraulic mortar, from one-half to three-fourths of an inch (.0127 to .0191 m.), was given them that they might always be brought to a true elevation and to furnish a perfectly even bearing when screwed down to the brick pier. The end of the bolts, together with the nuts, were then covered with a thick coat of coal-tar, and the whole base given a wash of pure cement mortar where the bases occur in the driveway. They were further protected by cast-iron bell-shaped fenders, which also prevent the wheel hubs of passing vehicles from striking the iron columns. The intervening space between the shell of the fender and the base casting was filled with cement mortar. Fig. 98 represents a fender in position, the base and column being shown by dotted lines.

ERECTION OF IRON STRUCTURE.

The iron structure is composed of Warren longitudinal girders of the deck system, whose upper chords rest upon the top chords of transverse girders of a similar character, supported by six segment wrought-iron columns of the Phœnix pattern. The transverse girders have a double-triangular system, whereas the longitudinals are of the plain triangular type. The longitudinal girders are set in pairs under each track, 5 ft. (1.524 m.) between centres. They are 4 ft. (1.219 m.) deep from out to out of chord angles.

The bottom chords of transverse girders are flush with the under surface of longitudinals, and made rigid therewith by plates and bolts. The transverse girders through Division and Allen streets, First avenue and Twenty-third street, are sized and fitted for the support of three tracks, and through Second avenue for four tracks.

Transverse girders weigh about 200 lbs. per lineal foot (297.4 kg. per m.).

Longitudinal girders weigh about 130 lbs. per lineal foot (193.5 kg. per m.).

Bracing, etc., weigh about 8 lbs. per lineal foot (11.9 kg. per m.).

"A" calibre columns weigh about 350 lbs. per yard (173.7 kg. per m.).

"B" calibre columns weigh about 420 lbs. per yard (208.4 kg. per m.).

The first step in the erection of the iron work was dropping the columns into their appropriate base castings. This was easily accomplished by means of a derrick wagon, by which seven men and a team of horses were able to set in place an average of 39 columns not exceeding 20 ft. (6.096 m.) in length; or ten columns not exceeding 50 ft. (15.240 m.) in length per diem. The space between the barrel of the base casting and the columns was then caulked with oakum to keep out the water prior to using the cast-iron cement, and the columns filled with cement mortar in proportion of two parts sand to one of cement.

The columns were held temporarily in place by inserting iron wedges inside the rim of the base casting. The girders were raised by a traveler on the structure. The power used was a 15-horse power engine, boiler shell, 3 ft. × 6 ft. (.914 m. × 1.828 m.). The force needed was 12 men besides the engine man. With the power and force named the contractor raised an average of 66 girders per diem of ten hours, equaling 200 tons (203.22 tons kg.), using one-fourth ton (253.11 kg. of coal).

The iron girders all being in place, the lateral bracing was then adjusted and riveted and the columns very carefully plumbed with heavy iron plumb-bobs, and in many cases of long columns with a transit instrument. After being brought to a vertical position they were thus held by jack-screws and braces until the cast-iron cement had been substituted for the oakum.

The cast-iron cement used consisted of the following proportions: One ounce (28.3g.) of sal

ammoniac to one gallon (3.79 l.) of water. The cast-iron turnings or borings were mixed with a minimum amount of the solution and left standing about half an hour before using, to "warm up." The mixture was then dropped in layers of ⅛ in. to ½ in. (.0032 m. to .0127 m.), not to exceed the latter, and very thoroughly rammed with iron rammers driven by vigorous blows of a hammer. For a "B calibre" base about 130 lbs. (58.97 kg.) of borings were required to perfectly cement the column and its base c eating. For a base of "A calibre" about 100 lbs. (45.36 kg.) were needed. It took about 48 hours to complete all evaporation, whereupon the cement became as hard as the iron itself. Much care was needed in preparing this cement. Unless sufficient water was used the cement would heat and be spoiled. The addition of sulphur one part to eight parts of sal-ammoniac hastens the process of hardening, but if time is allowed it sets more firmly without the sulphur. Hence, the use of sulphur was abandoned. It was also found absolutely necessary that the iron borings should be perfectly clean and free from rust. As an illustration of the efficiency of this cast-iron cement, it may be interesting to know that when occasion offered a column was removed from a cast-iron base after it had been thus cemented, whereupon it was found stronger than the base itself, the latter breaking first under powerful blows of a sledge.

I.—TRACK STRUCTURE AND TRACK LAYING.

1. The gauge of the track on tangents is 4 ft. 8½ in. (1.435 m). On curves of 600 ft. (182.9 m.) or less it is 4 ft. 9 in. (1.448 m.).

2. The track material consists of:

(*a.*) Southern yellow pine cross-ties 6 in. × 6 in. × 8 ft. (.1524 m. × .1524 m. × 2.438 m.), except on curves, crossings and turnouts, where greater lengths and larger sections were frequently used. Every third cross-tie on each track of the main line is a lookout tie 12 ft. (3.657 m.) long.

(*b.*) Southern yellow pine guard timbers 6 in. × 8 in. × 30 ft. (.1524 m. × .2032 m. × 9.14 m.) long and upwards for straight lines, and white oak guard timbers of like lengths 5 in. × 8 in. (.127 m. × .2032 m.) section for sharp curves and their approaches.

(*c.*) White oak bevel and distance blocks, cap stringers and shims for sharp curves.

(*d.*) Steel rails weighing 63 pounds per yard (31.23 kg. per m.), and usually 30 ft. (9.14 m.) long.

(*e.*) Fish plates, screw bolts, lag screws, clips, angle b ar and strap-iron guards, blunt bolts, spikes and nails. All materials were delivered along the line, in the street, by the company, the contractor thereon receipting for the same and assuming all further respo sibility. The accepted bids for track work were those of Messrs. D. R. Kelly and Quinn & Flinn, all of New York city. The following table shows the amounts and respective prices credited to each:

TABLE No. 6.

CONTRACT PRICES PAID FOR TRACK WORK, AND AMOUNT DONE BY EACH.

NAMES.		In Lineal Feet.								In Metres.		REMARKS.
		Tangents.		Curves.		3 Plank Walk.		Switches.		Frogs.		
		Length.	Price.	Length.	Price.	Length.	Price.	Number.	Price.	Number.	Price.	
D. R. Kelly		50,764.4	43c.	1,628	80c.	....	....	35	$3.00	41	$4.00	Turnouts and crossings all estimated as tangents. Switches to include furniture, and in working order.
Quinn & Flinn.		37,840.	35c.	....	....	31982	3c.	23	12.00	26	3.00	
D. R. Kelly	$1.41	15,481		496.2	$2.62½	....	9.75	35	$3.00	41	$4.00	
Quinn & Flinn.	1.46	11,533		....	....	....	3.2c	23	12.00	26	3.00	

II.—STRAIGHT LINES.

The cross-ties were spaced 18 in. (.4572 m.) from centre to centre, exce ing at rail joints, where shoulder-ties were used, spaces 6 in. (.1524 m.) in the cle r, from the joint tie. They were laid at right angles to the centre line of the track, with the outer ends in range. Wrought-iron clips and lagscrews were used to fasten them to the flanges of the longitudinal girders, two clips and two lagscrews to each cross-tie alternately inside and outside of the girders. The top of the cross-tie over each transverse girder was always true grade; whenever camber showed itself in the longitudinal girders it was taken out by adzing the under surface of the cross-ties. No shimming was allowed in any case. The rails are those known to the trade as "Erie Pattern," made of Bessemer steel with $\frac{35}{100}$ of one per cent. of carbon.

They were furnished by the Albany Rensselaer Iron and Steel Company, and met satisfactorily all requirements of the company's inspector. A test bar ¾ in. (.019 m.) square, and one foot (.305 m.) long was taken from each charge and required to bend 80 deg. without breaking, under a sudden pressure, on bearings of 8 in. (.2032 m.) asunder. Two bars out of three to stand this test in order that the charge might be rated first-class. If two out of three broke the charge was rated second-class, and rejected. An official test record was kept of all charges, and open to the company's inspection. A template for section was furnished by the company. It was found that although the manufacturers were very successful, generally, in meeting the requirements of the specifications, yet it was quite common to discover a slight "kink" near the end of the rail; this could not well be avoided with the straightening machine then in use at the mills.

They are placed to break joints in each track, the ends of them, on one side, laid as nearly as possible opposite the middle of those on the other side, and the joint made exactly over the middle of the tie, each rail was then spiked with two spikes in each cross-tie. The joints were left open ¼ in. (.0064 m.) when the temperature was below Fahrenheit zero; a scant ¼ in. (.0064 m.) between zero and 32 deg.; $\frac{3}{16}$ in. (.0048 m) between 32 deg. and 50 deg.; ⅛ in. (.0032 m.) between 50 deg. and 80 deg.; and $\frac{1}{16}$ in. (.0016 m.) above 80 deg. Only metal shims were used in regulating the spaces.

The guard timbers were laid both sides of the steel rails, and ex ctly 10 in. (.254 m.) apart, the inner one being 3½ in. (.0889 m.) in the clear from the gauge side of the track rail when complete, with strap iron. They were framed at the ends with a dovetail halving splice 9 in. (.2286 m.) long, tapering one inch (.0254 m.). The splices in all four guard timbers were made to break joints; screw-bolts were used to fasten the timbers at the joints Each guard timber was, as a general rule, bolted to alternate cross-ties, the inside and outside timbers being bolted in pairs respectively to the same tie, they were secured to the girder flanges by clips above the nuts of the screw bolts, the heads and washers of which were set down into a cup at top, bored with a 2 in. (.0508 m.) auger, deep enough to sink the head slightly below the top surface of the guard timber and permit the screw end of the bolt to project about ⅛ in. (.0032 m.) below the nut after screwing up for upsetting. The auger-hole cup was filled completely with a paste of Portland cement, and smoothed off a little crowning to shed water, prior to painting. All the bolts used in track-work, excepting fish-plate bolts, were greased with tallow before insertion, and all meeting surfaces of track timbers and other fixtures were given a thick coat of white-lead and oil paint before closing up.

III.—CURVES.

The general provisions concerning straight lines governed track-work on curves as far as they were applicable. The yellow pine ties were usually 10 ft. (3.048) long. To give the proper elevation of the outer rail, white oak bevel caps were used for the support of rails and guard timbers. The outer rail was elevated 3 in. (.0762 m.) calculated for a speed of ten miles per hour only; the elevation being gained in a distance of about 80 ft. (24.4 m.) on the tangent to the curve. The track-rails were curved by templets furnished by the engineer, true to line; no springing or sledging of rails was allowed, On curves with radii of 600 ft. (183 m.) and upwards each rail is held by three spikes per tie—two outside and one inside. On curves of less than 600 ft. (183 m.) radius, a steel guard rail was spiked down inside of the inner track rail; it was found necessary to plane off the flanges of this rail ¾ in. (.0191 m.) to permit the insertion of the screw bolts, or lagscrews; then steel guard rails were further supported and held upright in place against lateral shocks by white oak distance blocks, moulded to fit their sides, and extended nearly to the opposite guard timber, where they were "set up" by means of a wedge of oak; they were then bolted fast through the bevel blocks and cross-ties. On top of these distance blocks were bolted through cross-tie a white oak curved cap 3¾ in. × 10 in. (.0953 m. × .254 m.) section, partly covering the head of the steel guard rail; the inner face bein g 3⅛ in. (.08 9 m.) from the gauge side of the inner track rail. This was also guarded on the upper edge facing the track rail by a 5 in. × 8 in. (.127 m. × .0762 m.) angle bar secured by blunt bolts. These angles were in about 14 ft. (4.27 m.) lengths shaped to the curve with half check joints. The three remaining ranges of guard timbers for each track were composed of two white oak timbers, each 5 in. × 8 in. (.127 m. × .2032 m.) section clamped together sideways by bolts and lag screws, at intervals of about 1 ft. (.305 m.) They were then fastened to the cross-ties as on straight lines. Both ranges of guard timbers for the outside rails on curves were faced with strap iron, the timbers being spaced 6¼ in. (.165 m.) from the gauge side of the track rail instead of 6 in. (.1524 m.) as on tangents. The ends of the cross-ties were then sawed off true to the curve. Figs. 1 and 2 of Fig. 9, represent sections of the track for tangents and sharp curves. Owing to the fact of longitudinal girders on sharp curves being chords of the arc, and the consequent means of fastening the cross-ties varied, the different sections are more or less dissimilar.

It may be of interest to know the organization which was maintained during the construction of this novel and somewhat exceptional class of track-work. As the work was necessarily continuous, or was deemed best to be so, it was found that the most economical daily force employed should not exceed seventy men, distributed over a space of about half a mile, as follows:

15 carpenters.
10 skilled laborers to assist the same on guard timbers.
10 men laying steel rails.
10 " clipping cross ties.
10 " spacing, marking and adzing cross-ties.
10 unskilled laborers for derrick, distributing materials, etc.
2 horses with drivers.
3 foremen.

The clippers were usually kept about 500 feet (152.4 m.) ahead of the spikers, and the spikers 750 feet (228.6 m.) ahead of the carpenters on the guard timbers. Horse power was found to be cheaper and of more practical utility than steam in hoisting track material. The cross-ties were first hoisted, distributed and spaced; then marked for camber by means of T sights, adzed and clipped. Then the steel rails were in turn distributed, lined up and spiked; then the guard timbers were distributed, ends jointed, gauged and bolted down; the inside guard being put in place and finished with strap iron before the outside one was laid. A space of about 250 feet (76 m.) intervened between the gangs employed on the two ranges of guard timbers. Everything working smoothly, the above force accomplished about one block or 260 feet (79.25m.) of double track *per diem* of ten hours, on tangent work.

The following statement gives the actual cost to contractors Quinn and Flynn of laying complete one thousand lineal feet (304.8 m) of straight single track:

Hoisting and distributing materials	$40.00
Laying cross-ties	65.00
Hoisting steel rails	30.00
Hoisting guard timbers	100.00
Strap-ironing guard timbers	20.00
Incidentals, loss of time, repairing tools, etc.	25.00
Superintendence	20.00
	$300.00
Amount paid contractor as per prices bid	350.00
Profit	$50.00

or 16⅔ per cent.

The amount of materials required for the construction of one thousand ft. (304.8 m) of single track, is as follows:

250 cross-ties, 6″×6″×12′ (.1524 m.×.1524 m.×3.658 m.).
500 " 6″×6″×8′ (.1524 m.×.1524 m.×2.438 m.).
3,000 wrought iron clips 5⅛″×2¾″×½″ (.1397m.×.0635 m. ×.0127 m.)
1,500 lag screws, 6″×¾″ (.1524 m ×.0191 m.).
67 steel rails, 30′ (9.144 m.) long.
67 fish-plates, 30″×2¼″×¾″ (.5082 m.×.0635m.×.0191m.).
268 " " bolts, 4″×¾″ (.1016 m.×.0191 m.) with nuts and washers.
3,000 spikes.
7,000 lineal ft. guard timber, 6″×8″ (.1524 m.×.2032 m.).
1,500 guard rail bo ts, nuts and washers, 14⅛″×¾″ (.3684 m.×.0191 m.).
150 lag screws, 1′2″×¾′ (.305 m.×.0191 m.).
2,000 lineal ft. strap-iron, 2½″×½″ (.063 m.×.0127 m.) section.
300 strap iron bolts, 6½×½″ (.1651 m.×0127 m.) with nuts and washers.
300 blunt bolts for strap-iron, 5″×½″ (.127 m.×.0127 m.).
¾ barrel Portland Cement.

TURNOUTS AND CROSSINGS.

To lay one typical crossing, consisting of 218 lineal feet (66.5 m.) of track, with five frogs, from switches and guide guard timbers, with inside steel guard rails, costs as follows:

Hoisting, adzing and clipping cross-ties	$18.25
Laying rails, frogs and switches	40.00
" guard timbers	12.50
" steel guard rails	4.25
Total	$75.00
Amount paid contractor as per prices bid	139.30
Profit	$64.30

or 85 7-10 per cent.

SIDEWALKS THREE PLANKS WIDE.

Cost to contractor per 1,000 lineal ft. (304.8 m.)	$15.00
Amount paid contractor as per prices bid	25.00
Profit	$10.00

or 66⅔ per cent.

PAINTING.

In mixing paints for iron surfaces, it is of the first importance that the best materials only be used. Linseed oil is the best medium, when free from admixture with turpentine; the latter being a volatile oil, cannot be used with advantage on a non-absorbent surface. Linseed oil, however, is peculiarly well adapted for this purpose. It does not evaporate in any perceptible degree. The large percentage of linolein which it contains combines with the oxygen of the atmosphere, and

(*Continued on page 370.*)

ENGINEERING NEWS
AND
AMERICAN CONTRACT JOURNAL.

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GEO. H. FROST.....EDITOR AND PROPRIETOR.

S. D. V. BURR.....ASSOCIATE EDITOR.

SATURDAY, OCTOBER 21, 1882.

EDITORIAL ANNOUNCEMENTS.

Terms of Subscription.—To the United States and Canada, $4 per annum, including postage; all parts of Europe, $5, payable in advance. Remittances at the risk of the subscriber, unless made by registered letter or by draft, check or P. O. order, payable to GEO. H. FROST.

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Articles for Publication in the current number should be received at the office of publication not later than Thursday morning, and advertisements not later than Friday noon.

Correspondence upon subjects which naturally belongs to the province of this journal is solicited.

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NOTICES OF MEETINGS.

JOINT SESSION OF ENGINEERING SOCIETIES.

There will be a joint session of the American Institute of Mining Engineers with the American Society of Civil Engineers and the American Society of Mechanical Engineers at the Turf Club (formerly Union League) Theatre, corner of Madison avenue and Twenty-sixth street, New York, on Wednesday evening, Nov. 1, at 8 o'clock, for the purpose of hearing the memorial address on the life and works of the late Alexander Lyman Holley, to be delivered by R. W. Raymond, Ph. D.

AT the meeting of the American Public Health Association, at Indianapolis, on the 18th, Dr. T. P. Wilson, of Ann Arbor, read a paper on "Life on Wheels," estimating that there were constantly a million and a half people travelling on railroads besides those employed on the lines. He was convinced that more attention should be given to the hygienic needs of railroad travellers. Erastus Brooks, of New York, described the Board of Health system of New York State.

THE tenth annual meeting of the American Public Health Association is in session this week at Indianapolis, Ind. Meetings were held the 17th, 18th, 19th and 20th inst. Papers were read upon "Sanitary Associations," "Heredity," "Disease in the White and Black Races," "Sanitary Organization," "The Progress of Sanitary Science," "The Contagious Character of Tuberculous Consumption," "Sewers," "Cattle Disease," "The Disposal of Sewage," "Vaccination and Criminal Vaccination," "Smallpox," etc.; reports of committees, etc. The President for 1881-82 of the Association was Prof. R. C. Kedzie, of Lansing, Mich.

THE Grand Jury of Monmouth County, N. J., have been "making things hot" on sanitary infringements in that vicinity. For publishing articles alleging that typhoid fever was epidemic in Red Bank, the proprietor of the *Register* of that place has been indicted and bound over for trial; Jas. N. Corey, the belligerent proprietor of the fever-infected Hotel Bellevue, at Seabright, has to answer to five indictments, and charges are presented against several of the hotel owners and other property holders at Seabright for polluting the South Shrewsbury River with sewage. The Board of Commissioners of Long Branch and Asbury Park, the Ocean Grove Camp-meeting Association, and the Ocean Beach Land Association, are also censured for allowing offensive substances to pollute bodies of water within their jurisdiction.

It is time to adopt active measures for the protection of residents at summer resorts. A few years ago the need was not appreciable, but now that these resorts are so crowded in the warm season, it is an absolute necessity to provide suitable sanitary provision for the safety of those who pay the extravagant prices that are exacted at summer hotels and boarding houses. From the White Mountain region even, where malaria never claimed a residence, reports now come of its arrival with the ever swelling number of visitors, who for a while each year seek comfort, health and amusement amid its hills.

WE want statistics of the water-works of the following cities of 10,000 inhabitants, and will furnish blanks to any person who will be so kind and accommodating as to fill them out, and otherwise assist us in the matter:

Biddeford, Me.	Mobile, Ala.
Brockton, Mass.	Muskegon, Mich.
Burlington, Vt.	Portland, Or.
Canton, O.	Pottsville, Pa.
Chattanooga, Tenn.	Rock Island, Ill.
Cohoes, N. Y.	Rutland, Vt.
Columbus, S. C.	Sacramento, Cal.
Davenport, Ia.	Saginaw, Mich.
Dover, N. H.	San Antonio, Tex.
Easton, Pa.	San Jose, Cal.
Evansville, Ind.	Shenandoah, Pa.
Galveston, Tex.	Springfield, Ill.
Haverhill, Mass.	Stamford, Conn.
Hyde Park, Ill.	Stockton, Cal.
Joliet, Ill.	Steubenville, O.
La Crosse, Wis.	St. Joseph, Mo.
Lewiston, Me.	Wheeling, W. Va.
Little Rock, Ark.	Youngstown, O.
Los Angeles, Cal.	

If water-works officials would for a moment realize what relief we are endeavoring to bring them in a complete "History and Statistics of American Water-works," they would certainly hasten to send us all the information they possess. Once this volume is ready for distribution, a printed postal card, referring all inquirers after statistics to the recognized Encyclopedia, is all that will be necessary. An era of rest for circular-besieged superintendents is dawning, and we claim their co-operation in trying to save themselves. One more circular, properly filled out, and their labors as statisticians are nearly ended, and we will, single-handed, undertake to do all that the 600 and more cannot now do.

THE FEE OF THE STREETS.

Mr. Rufus Story, a coffee and spice merchant at Nos. 7 and 9 Front street, of this city, has at last brought the Grand Moguls of the Elevated Railway to something in the nature of "terms." From March to November, 1877, he had the New York Elevated Railway Company enjoined from making excavations in front of his property, for the purpose of building their railway. Judge Robinson, in the Court of Common Pleas, then dismissed the case, dissolved the injunction and left Mr. Story $1,323 out of pocket for costs and disbursements. Mr. Story carried the case to the Court of Appeals, and on Tuesday scored a victory over his opponents.

The case was re-argued before this Court of last resort on the broad question involving the right of the property-owner to an easement in a public street that entitles him to have it maintained as a public street, or recover damages to the extent of the actual injury to the property by reason of its use for an elevated railway. This important point was decided by a majority of the Court, and it establishes the rule of law that guarantees to property-owners compensation for injuries to property by the construction of an elevated railway. It means, stripped of all legal verbiage, that the construction of an elevated railway on a public street of New York will entitle any property-owner to damages to the extent that the property is actually lessened in market value by reason of the railway; and the broad ground on which the principle is decided, would seem to make the same legal rule applicable to other cities.

The case naturally excites a great deal of interest, and is commented on by all the leading journals of this and the other large cities of the Union. A new trial is ordered for condemnation purposes.

The opinion in full is as follows:

First—That the plaintiff, by force of the grant of the City to his grantors, has a right or privilege in Front street which entitles him to have the same kept open and continued as a public street for the benefit of his abutting property.

Second—That this right or privilege constitutes an easement in the bed of the street which attaches to the abutting property of the plaintiff and constitutes private property within the meaning of the Constitution, of which he cannot be deprived without compensation.

Third—That such a structure as the Court found the defendant was about to erect in Front street, and which it has since erected, is inconsistent with the use of Front street as a public street.

Fourth—That the plaintiff's property has been taken and appropriated by the defendant for public use without compensation being made therefor.

Fifth—That the defendant's acts are unlawful, and as the structure is permanent in its character, and if suffered to continue will inflict a permanent and continuing injury upon the plaintiff, he has the right to restrain the erection and continuance of the road by injunction.

Sixth—That the statutes under which the defendant is organized authorize it to acquire such property as may be necessary for its construction and operation by the exercise of the right of eminent domain.

Seventh—In view of the serious consequences to the defendant, we think no injunction prohibiting the continuance or operation of the road in Front street should be issued until the defendant has had a reasonable time after this decision to acquire the plaintiff's property by agreement or by proceedings to condemn the same.

Mr. John E. Parsons and William M. Evarts argued the case for the appellant, Story, and David Dudley Field for the Elevated Railway Company, respondent. Judge Tracy delivered the opinion. The opinion in full is published in the N. Y. *Times* of the 18th; the adverse opinion of the minority judges is published in the N. Y. *World* of the 19th. Both combined are of great interest and value on account of the legal information respecting the fee of streets embodied therein.

President Jay Gould, of the Manhattan Company, said to a reporter of the *World:* "The decision cannot affect the Manhattan Elevated Railway Company, since by a covenant in the leases it was expressly stipulated that the Manhattan Company should not assume the payment of such damages. The New York Company is protected by its agreement with the city, contained in the original charter, by which it was stipulated that the company should pay to the city 5 per cent. of its net earnings annually. The Metropolitan Company has no such grounds of defense, and the decision may result in closing the Fifty-third street branch, but even then all travel from Harlem could could down town by the Ninth avenue line direct."

Vice-President Gallaway said also: "The decision may result in the necessity of closing the branch of the Metropolitan along Fifty-third street, and so shut off the Harlem connection."

"In that event could you not extend the line from Fifty-eighth street to tap the line to Harlem?"

"Unfortunately that is what might be called an 'engineering impossibility,' on account of the lay of the land, even if we could get the right of way. The engineers, in running the survey to Harlem, ascertained that Fifty-third street was the first street coming down that could be utilized for the connection. At any point above that the grade would be so steep that the road could not be run."

THE INDUSTRIAL OUTLOOK.

The situation of the iron market is less favorable than a month ago. The western mills and furnaces are producing to their maximum capacity, but buyers are coming forward with considerable caution, born of the belief, or apprehension, that the resumption of iron making in so many mills and furnaces is destined to create an over supply and effect a corresponding reduction in prices. This seems to be the only plausible explanation of the quietness which characterizes the markets East and West after a four months suspension in a large portion of the country. Another cause deserving of attention is that the crops, although very large and up to commercial expectations, are coming for-

Vis-à-vis page 363

THE METRO

BY THE

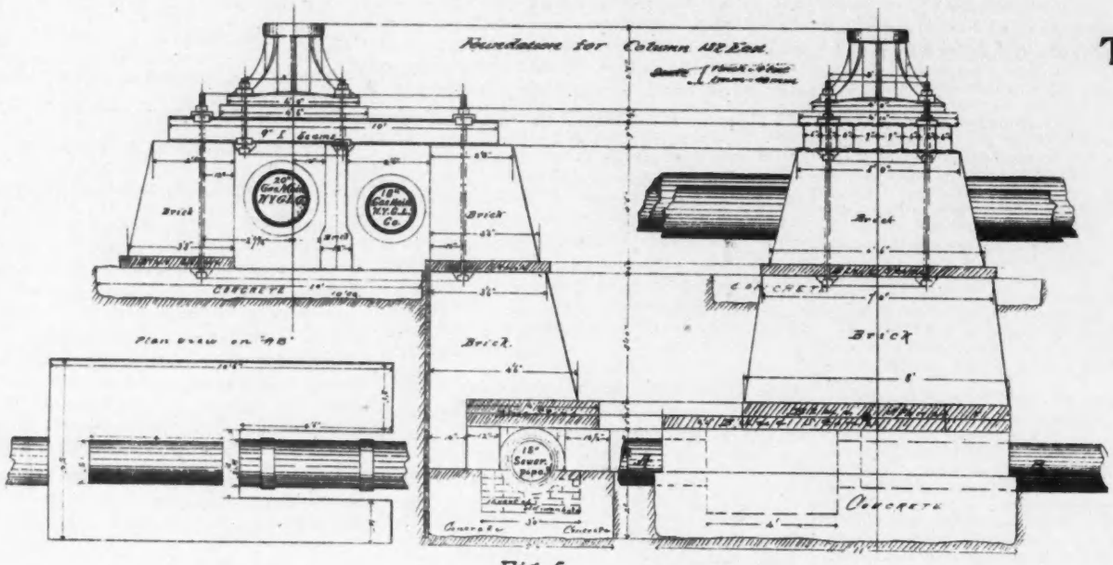


Fig. 5

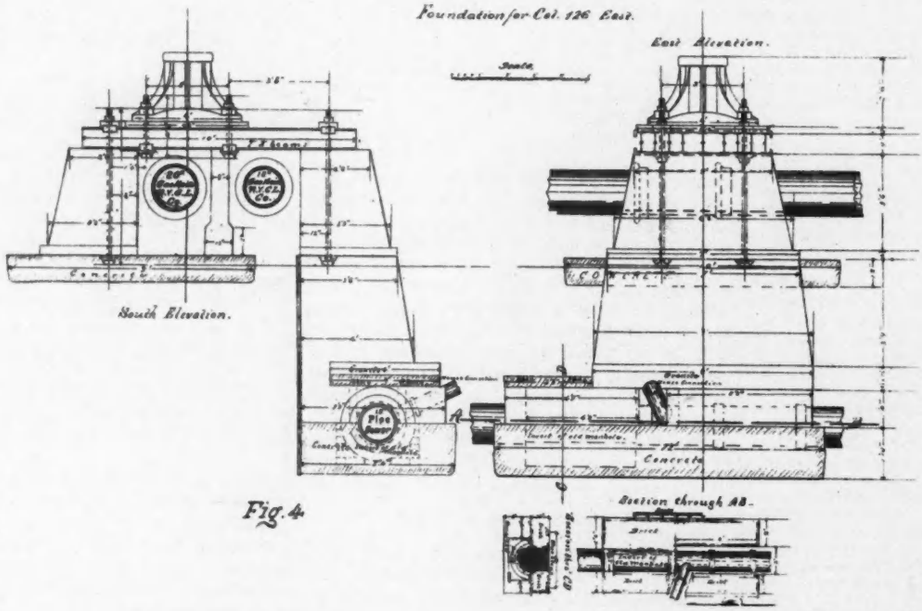


Fig. 4

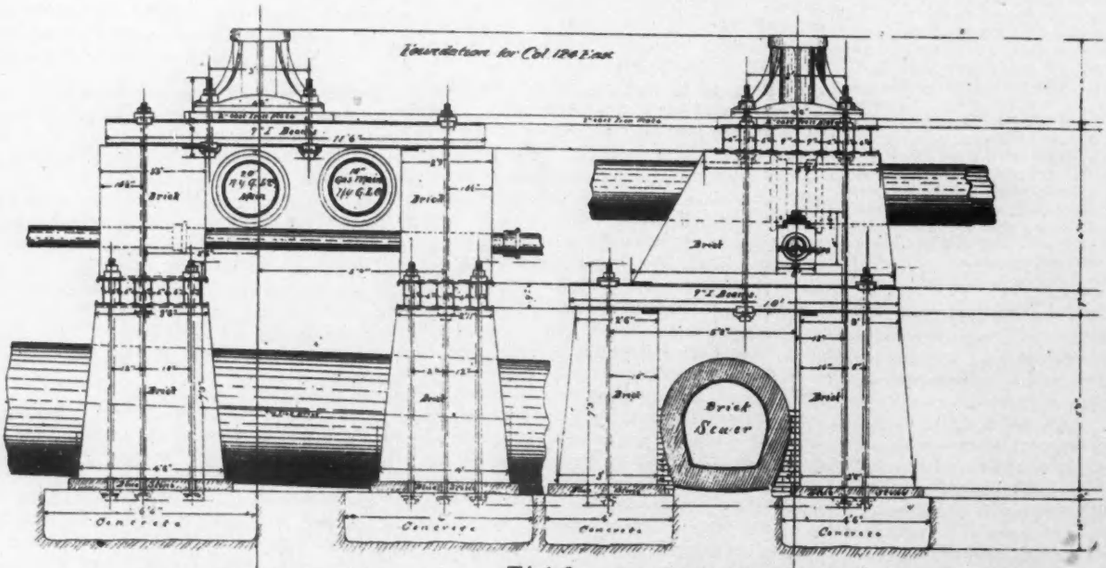


Fig. 3

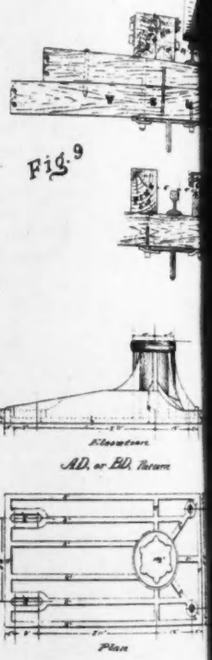


Fig. 9

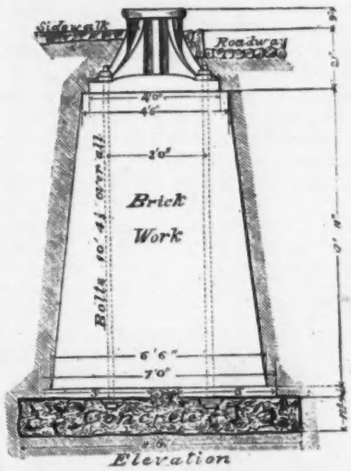
TAN ELEVATED RAILROAD.

G. THOMAS HALL

M. SOC. C. E.

APRIL 20 1881.

Standard Sidewalk Pier



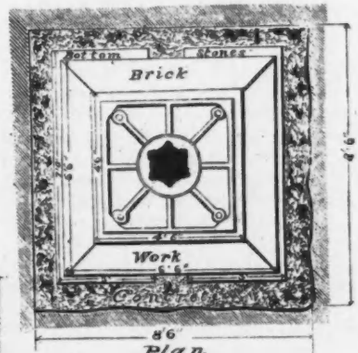


Fig. 2

Standard Street Pier

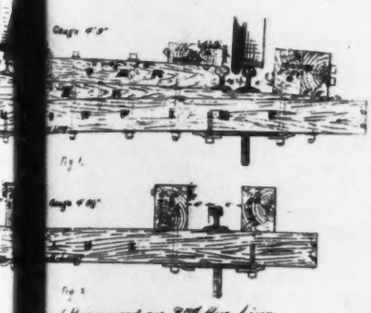


Fig. 7

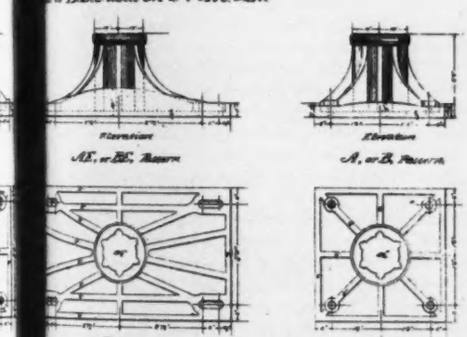
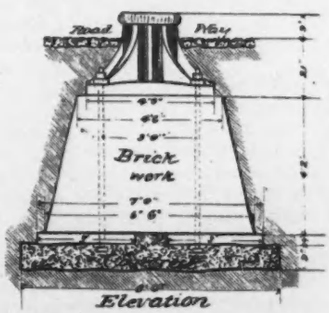


Fig. 6



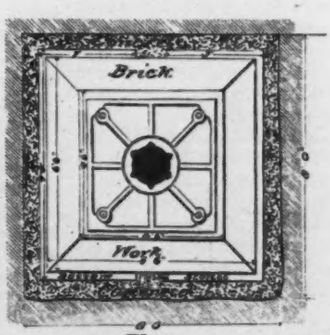


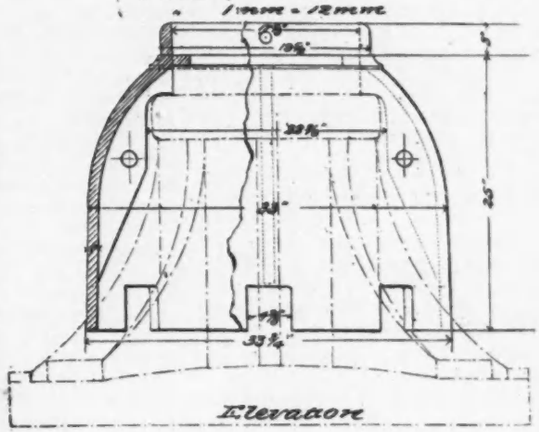
Fig. 1.

Fender

Used on 2nd Ave.

Scale 1" = 1 foot

1 mm = 12 mm



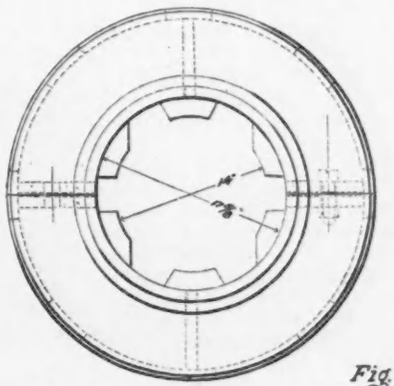


Fig. 8

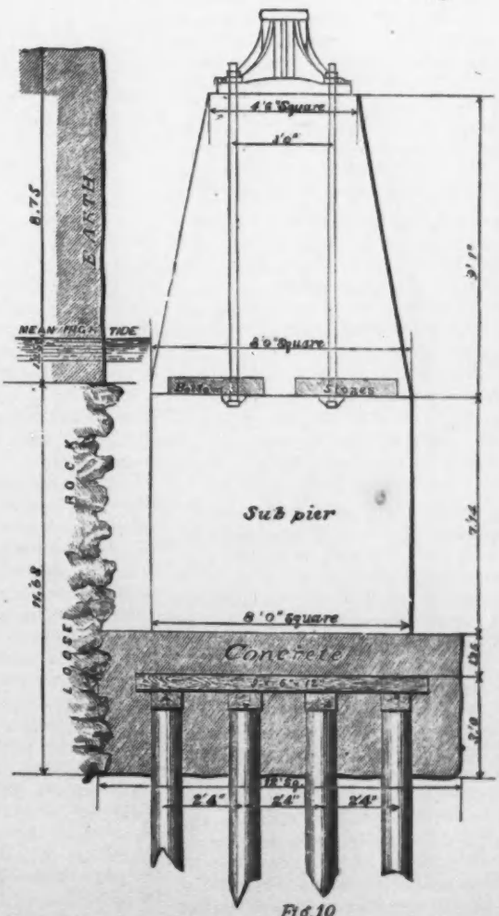


Fig. 10

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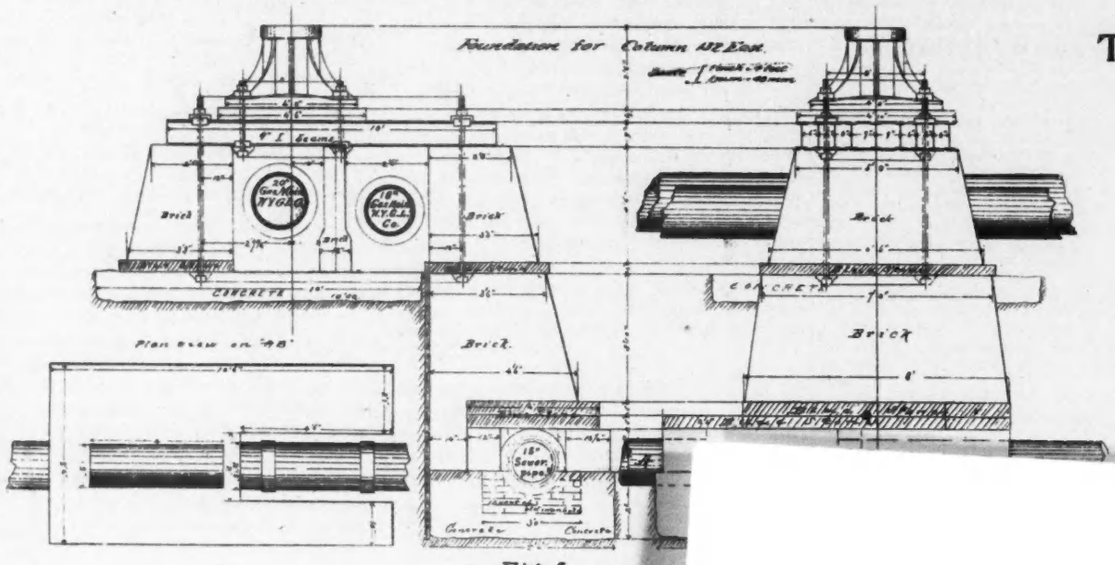
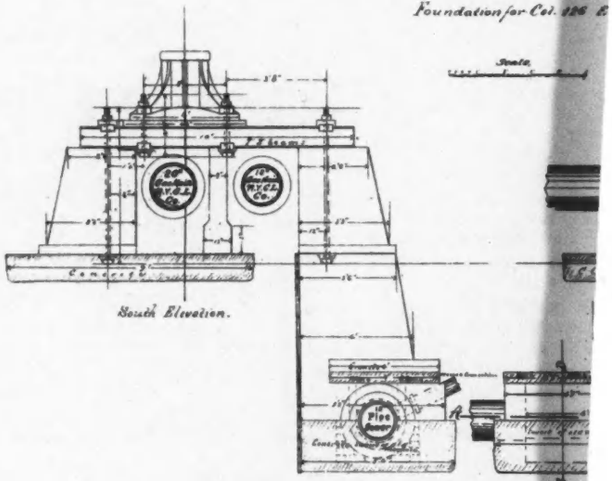


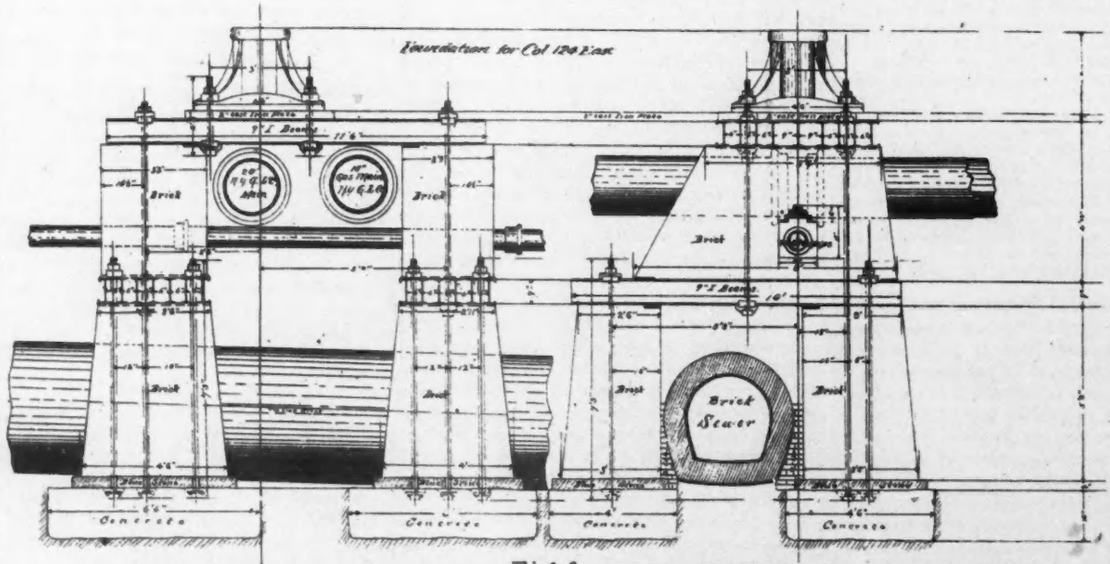
Fig. 5

Foundation for Col. 126 E



South Elevation.

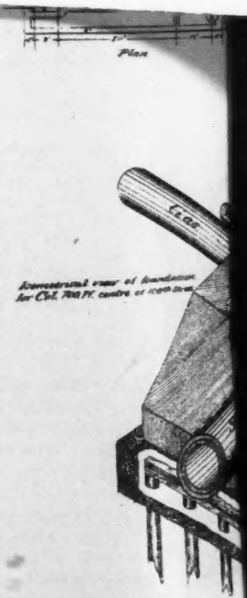
Fig. 4



South Elevation

Fig. 3

East Elevation



TAN ELEVATED RAILROAD.

G. THOMAS HALL

M. SOC. C. E.

APRIL 20 1881.

Standard Sidewalk Pier

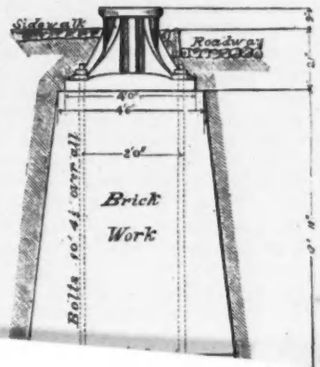


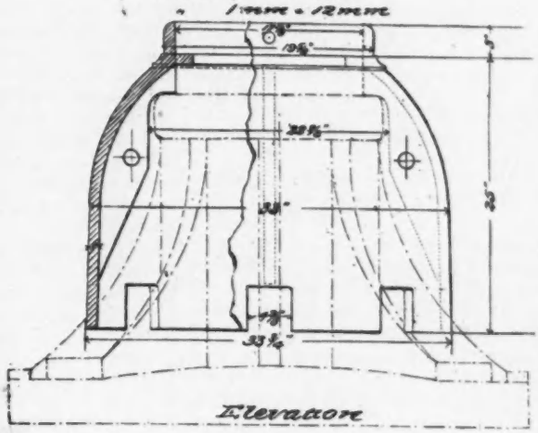
Fig. 1.

Fender

Used on 2nd Ave.

Scale 1" = 1 foot

1 inch = 12 mm



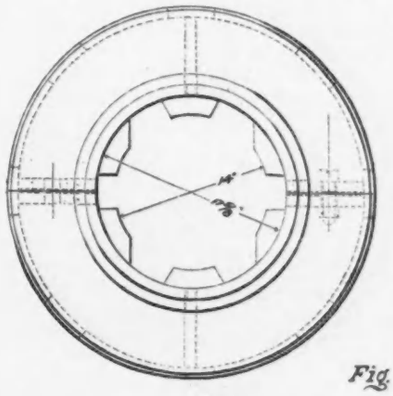


Fig. 8

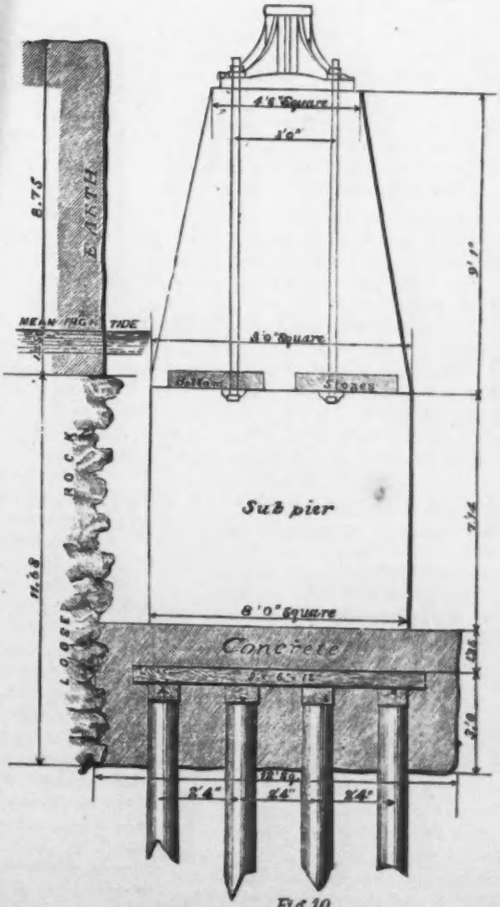


Fig. 10

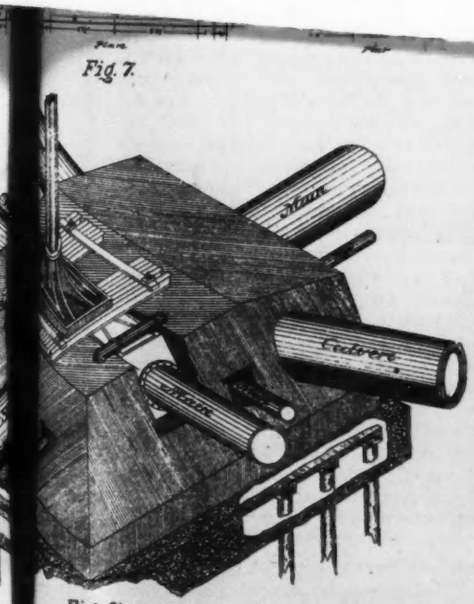
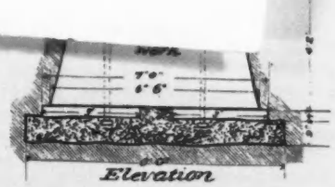
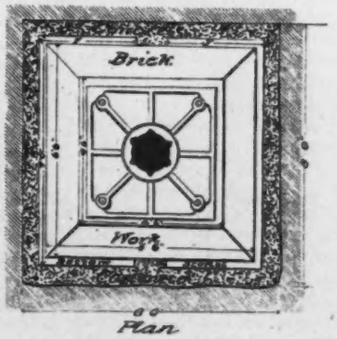


Fig. 6

Fig. 7.





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ward rather slowly. The reports of the Trunk line roads from Chicago eastward show that the shipments are considerably below those of last year, although improving every week. An active iron market will not be enjoyed until the crop movement assumes normal proportions, and consumers generally, in all lines of activity, present demands for their winter requirements. There is no reason why the industrial activity of the coming winter will not be greater than that of any former season. All the factors in the problem are favorable to it. Threatening storms of financial stringency have hovered over the horizon, but instead of having an unfavorable effect, they warned manufacturers, middle men and consumers that it is wisdom to go slowly and buy only what is needed and to let future requirements take care of themselves. At no time in our history perhaps was business conducted on a more legitimate basis. Furnaces and mills of course are sold ahead for a few weeks, but there is none of that wild anticipation of wants which characterized the trade a year ago. The reason is simply that the productive capacity of the country has increased to such dimensions that it is not necessary that buyers should buy three or six months ahead, assuming the risks of fluctuating prices in the mean time. Supply is equal to requirements, but it must be observed that there is a very rapid expansion of productive capacity in several directions, for instance, new rolling mills are going up, new blast furnaces are being projected and built, old furnaces are being repaired, and fresh appliances used to secure greater production. All these elements point to such a growth of production as in time will create an over production, which will lead to the necessity for restriction in some shape or other, unless requirements expand correspondingly, but even then the greater demand stimulates enterprise, and it is only a question of time when more iron and steel will be made than can be sold at a good profit. It will be perhaps a long time before the production will be so great as to destroy profits, but the industry is traveling in that direction. This fact is recognized by consumers and by projectors and investors, hence demand is limited to actual requirements. Bridges and roads can be built cheaper next year than this, and on this account there is none of that enterprise which in former years has been productive of disaster. The foreign situation is satisfactory. The workmen in the iron mills, following in the footsteps of their American brethren, demanded an advance, but fortunately selected a time when the employers had but one choice to make, and they made it wisely. The coal miners have requested a 15 per cent. advance, but will not discontinue work until November 1st, when it is said they will leave the mines unless their demands are complied with. American pig-iron is selling at $27 at furnace for standard brands of No. 1 Foundry, $24 to $25 for No. 2, and $22 to $23.50 for Gray Forge. Nearly all the furnaces are sold ahead up to December 1st. Very few buyers care to buy beyond this date. English Bessemer Pig is offered at $24, but American consumers will not pay over $23. The steel-rail mills are pretty well crowded with orders for the winter, the business of the past month aggregating 200,000 tons, which is about the full productive capacity. Large, round lots can be placed as low as $44, and it is probable that this will be the figure for 1883. It is said in some quarters that even lower prices will be reached. Capacity is being increased, and steel-rail makers recognize the necessity of adopting every device and expedient to reduce the cost of rails. A large number of new enterprises have been presented within a few weeks, covering not less than one thousand miles of road in the South, Southwest and far Northwest. The mileage constructed this year to date is 8,300 miles, and will, no doubt, reach 10,500 by the close of the year. Railroad dividends are in the main encouraging. The last returns of fifty-eight roads show four earned over 50 per cent., four over 25 per cent., and twenty-five over 25 per cent. But five of the entire number showed a decrease in earnings. The general condition of railroad interests is improving. The enormous crops promise an increase in traffic sooner or later, but the farmers at present are holding back their wheat for the sake of better prices. So far, Northwestern receipts show a decline of 25 per cent. for the season, and the Atlantic receipts show a decline of 53 per cent. The grand receipts of all kinds are 17½ per cent. less than last year to date, and 27 per cent. less than in 1880. The corn crop, which during 1880 and 1881 was over 1,700,000 bushels, will not reach 1,200,000 this year. As indicating the decline in cereal movements, Chicago's receipts for three months past were less than 34,000,000 bushels, as against 49,000,000 bushels for same time last year. These commercial indications are deserving of attention. Our industrial activity is dependent upon the volume of agricultural, mineral and manufactured products, and upon the profitable exchanges effected through the channels of commerce. Should no causes arise to arrest the spirit of enterprise or intimidate the large volume of capital waiting for a favorable opportunity, we can rest assured that the coming winter and spring will make a season of great undertakings, and the development of a number of enterprises which will furnish abundant employment to the millions of idle capital and to all of the labor and skill which America can command. While there are abundant evidences of prosperity about us, there are unfavorable indications which should be watched not only by business men and manufacturers, but by law makers. The spirit of speculation is waiting for opportunities to take advantage of circumstances and necessities. The great industrial interests have nothing to gain by speculation. It is one of those results and conditions which follow industrial enterprises like the hangers on of an army. There is abundant room for legitimate enterprise and for all capital which desires investment. The great South is opening up to Northern enterprise and most encouraging opportunities are being presented and accepted. Several lines of roads will be completed during the coming year, which will render accessible an enormous extent of country hitherto completely locked up. In the New England and Middle States manufacturers are finding an improving trade in providing for the requirements for machinery and for products for these sections. Nothing but bad management or excessive greed of speculators in stocks or conscienceless manipulators of values as represented in railroad bonds and stocks of various kinds can lead the industries to shipwreck or check our unprecedented growth of prosperity.

OBITUARY.

HENRIQUE HARRIS, Chief Engineer of the Long Island Railroad Company, died of diphtheria at his residence, 212 Adelphi street, Brooklyn, on the 10th inst. Mr. Harris was a native of Maracaibo, Venezuela, S. A., but nearly all his life was spent in the practice of his profession in this country. He graduated from Rensselaer Polytechnic Institute in the class of 1861. He was for many years an assistant engineer on the Parks and Water Works construction of Brooklyn, from which latter he resigned to accept the position of engineer of the New Brunswick, N. J., Sewerage and Street Departments, which position he resigned to accept charge of the engineering works of the Manhattan Beach Improvement Company. He was engineer for the sewerage of the Manhattan Beach and Oriental hotels, but would not allow his name to be associated with the sea-wall protection of these properties. He was, however, retained by Mr. Corbin as Chief Engineer of his Long Island Railroad system, and it was in his tireless devotion to the interests of this work, to the neglect of his personal health, that his sickness and death resulted. A neglected cold, a fatigued and over-worked mental and physical system, and the restless, nervous, excitable nature had to succumb to death. Mr. Harris was a brilliant man and an ardent lover of his profession, unusually well informed upon all subjects connected with it, scrupulously honest, an earnest and untiring worker, and, in his death, the engineering profession loses one of its most valuable men. He was rapidly rising to a prominent position, and all who knew him well found him a man of unusual ability. In his social life he was a most generous and courteous gentleman, and no man would do more to assist a friend. Mr. Robt. Van Buren, chief engineer of Brooklyn, his most intimate friend, took charge of him during his sickness, and will attend to all his affairs until his brother, who lives in Maracaibo, can be heard from. Mr. Harris was a member of the American Society of Civil Engineers, and a committee was appointed on Wednesday evening to prepare a memorial of his life.

PERSONAL.

LYMAN BRIDGES, M. Am. Soc. C. E., of San Francisco, Cal., sailed for Europe in the City of Rome on the 14th.

COL. GEORGE E. WARING, JR., Sanitary Engineer, will sail for Europe immediately on the completion of some special work on which he is now busily engaged at Pittsfield, Mass.

MR. CHARLES A. ROBERTS of Fargo, Dak., has been appointed General Manager of the Sanborn, Cooperstown and Turtle Mountain Railroad, in addition to his duties as chief engineer of this new company.

MESSRS. RICE, BRADLEY & SMITH, general contractors, Billings, Montana, is the name of a new firm of "young men" who have "gone West" in quest of fortune. GEO. D. RICE, of the firm, was formerly Secretary of the Boston Society of Civil Engineers. The new firm will succeed, of course.

MR. E. S. CHESBROUGH, Consulting Engineer of this city, sailed for Europe in the Alaska, of the Guion Line, on Tuesday, the 17th, to be absent about three months. Mr. CHESBROUGH'S visit is to investigate some special features of European sewerage systems, and he will go as far East as Berlin and Vienna. He will also visit Spain before he returns, but not in connection with the particular objects of this trip.

MR. GEORGE S. MORISON, Chief Engineer of the Bismarck Bridge, has issued a number of invitations to engineers and others interested in bridge-building to be present at the testing of the completed bridge on this Saturday, the 21st. Free transportation is furnished by all the trunk lines running west from Chicago to St. Paul, from which latter city a special train on the N. P. R. R. conveys the guests to Bismarck. A reception and banquet by the business men of Bismarck will follow the bridge testing exercises.

MR. G. W. VAUGHN has resigned the position of chief engineer of the Chihuahua Division of the Mexican Central Railway, which has been built under his skillful supervision, and has accepted the position of chief engineer of the Mexican National Railway, Southern Division, with headquarters at the city of Mexico. He has started for that city, going from Laredo overland for the purpose of inspecting the route from Monterey to the City of Mexico, and of making observations as to the resources of the country. The Mexican National is to be congratulated on securing so able an engineer as Mr. Vaughn.

NORTHERN PACIFIC RAILROAD.—The duties of the Inspector of Track, Bridges, and Buildings are extended to include a supervision of all the records of the Road Department on the several divisions in operation. He will be authorized to make such changes in said records and in the manner of keeping the accounts as will ensure uniformity, and furnish all the items of information required to fill the blanks in the forms prescribed for the annual reports. Division superintendents, roadmasters and other officers having charge of track, bridges or buildings will submit all books, records, and accounts having reference thereto to the examination of the Inspector, F. H. LEWIS, and will make such additions or alterations thereto and such reports from time to time as he may direct. The Inspector will keep in his office such records as will furnish the General Manager at all times with full information in reference to the condition of

the track, buildings and bridges on the several divisions, the number of laborers employed, the prices paid, the cost of all structures, the expenditures for repairs, maintenance, or betterment, the material on hand, and the amount and value of all purchased or consumed on each division.—H. HAUPT, General Manager.

PROPOSALS RECEIVED FOR HARBOR WORK.

We are indebted to Mr. Stickney, of the firm of Carkin, Stickney & Cram, contractors, of East Saginaw, Mich., for the following list of bids for building cribs and dredging at the harbor of Grand Marais, Mich., opened at Milwaukee, on Sept. 23, 1882, for the United States government:

NAMES OF BIDDERS.	Pine timber.	Hemlock timber.	Plank, per M. B. M.	Dr ft bolts.	Screw bolts.	Spikes.	Stone cover'd, 12 c. ft.	Dredging, per cu. yd.	Total amount.
	L. ft.	L. ft.	$	Ct.	Ct.	Ct.	$	Ct.	$
Knapp & Gillan, Wis	32	32	25	4½	6½	6	10.50	34	(3,180.00
Green Bay Dredging & Pile Co., Wis	33	33	20	5	6	5½	10.00	30	61,985.00
John H. Gillett, Mich.	29	29	16	4⅛	5	4	10.00	30	57,608.00
Ch s S. Barker, Mich.	32	32	18	4⅛	5½	5	8.00	25	55,079.00
Carkin, Stickney & Cram, East Saginaw, Mich.	31½	30	20	4	5¼	7	9.50	22	56,185.00
Caul. P. McDougald, Minn.	37	37	20	7	7	7	12.00	50	76,080.00
Green Dredging Co., Chicago, Ill.	36	35	20	5	6	5	12.00	30	68,110.00

Awarded to Chas. S. Barker.

PHILADELPHIA WATER.

Messrs. E. S. Chesbrough, J. Vaughan Merrick and Frederick Graff, the engineers selected by the Mayor to report to the Councils upon the water supply of Philadelphia, presented a partial report to the Common Council on the 19th. They find that in supplying lower levels of the city the existing machinery has been worked to its utmost capacity; that at the two largest steam works there is no spare machinery and in two others the whole supply depends upon one engine in each, and that at the present rate of annual increase in the consumption there will not be enough pumping power during the driest seasons of next year to sufficiently supply an area containing two-thirds of the population, while in 1884 there will be a short supply almost throughout the whole city. They regard the following-named machinery and appliances as imperatively needed for the supply of water to the city in the summer of 1883:

For the Schuylkill Works—Two 15,000,000-gallon engines, to pump, one against 150 ft. and one against a higher head, $96,000; two ranges of boilers and connections, $60,000; two forcing mains, $30,000; completing 48-in. main, partly laid, $14,000; boilers and engine house, $40,000; foundation for same, $10,000; total, $250,000.

For the Roxborough Works—One 7,500,000-gallon engine, to pump against 360 ft. head, with forcing main in houses $50,000; removing old and substituting two boilers and connections, $7,000; new inlet screen and dredging, $3,000; total, $60,000.

Distributing mains to supply Germantown from Mount Airy Reservoir to Manheim and Green, $70,000.

For the Frankford Works—One 10,000,000-gallon engine and connections, to pump against 200 ft., $45,000.

ESTIMATES OF THE COST.

The estimates given for the engines refer to the Worthington compound duplex, and they recommend cylindrical tubular boilers at the Roxborough works, and for the Schuylkill works marine tubular boilers.

"Your board," they continue, "are satisfied of the great importance of an early completion of the East Park Reservoir, of the need of a reservoir at Cambria and Thirtieth streets, and of increasing the size of the reservoir at Mount Airy. The appropriations for these reservoirs are next in importance to those for the machinery, for which estimates have been given. Expenditures under such appropriations would extend over a period of at least three years—1883 to 1885. Following are the estimates of the probable cost:

"East Park Reservoir and connections—completing two basins, $400,000; completing third basin, $300,000; forcing mains, $126,000; distributing mains, $371,200; total, $1,197,200.

"Cambria Reservoir and connections—Land, $100,000; 150,000,000 gallon reservoir, $375,000; forcing and connecting mains, $240,000; distributing mains, $105,000; total, $820,000.

"Mt. Airy Reservoir—Land, say $25,000 75,000,000 gallon reservoir, $225,000; total, $250,000."

These sums make a total of $2,267,200, of which the engineers say $647,500 should be expended in 1883, $795,000 in 1884 and $854,700 in 1885.

THE GRAVITY PROJECTS.

"In considering the question of present supply," the report continues, "it should be borne in mind that at least five years must elapse before a gravity system such as is contemplated by the Perkiomen and Delaware projects could be accomplished. At least one year would be spent in making surveys plans and detailed specifications. Their discussion and adoption would consume another year at least, and the construction of the works would take three or four years more. This is a sufficient reason for providing for an adequate water supply by steam pumping machinery and by storage in reservoirs up to 1888. Complete surveys must be made and reliable data obtained of the localities from which a pure water supply can be drawn. An appropriation of not less than $15,000 is suggested for such surveys.

"At each of the pumping stations there are now two engineers of equal authority, who are on duty alternately during the day and the night. Thus there can be no definite responsibility or uniformity of management." The board recommend that one superior engineer be placed in charge of each station. He should in all cases be responsible only to the head of the department. They consider the salaries now paid the engineers less than the pay of good mechanics in proportion to the time they are on duty, and far below what is paid in other cities for similar work.

MISCELLANEOUS SUGGESTIONS.

They also suggest that the several pumping stations and reservoirs should be connected together and with the Purveyors' and central office by telephonic communication. The board have been deeply impressed by the vital necessity of keeping out of the inlets to different pumping wells a large and constantly increasing amount of offensive sewage. They believe "that this great evil, so far as it proceeds from the sewer that empties into the Schuylkill River at the east end of Girard avenue bridge, can be abated at an early day and at a cost small in comparison with the importance of the object. This, however, belongs to the Survey Department of the city, which has also under consideration methods for keeping the sewage of Manayunk and the points below it out of the river above Fairmount dam."

Appended to the report is a table showing the pumping capacity and consumption for a number of years, and another table showing the organization and wages in different cities. In a marginal note the board say that if the large engine at Frankford breaks down there will be a short supply at Frankford, and if the larger engine at Roxborough or its boilers break down a failure at Germantown will be the result. The report was referred to the joint committee on water and finance.

BRIDGE PROPOSALS RECEIVED.

The following is a list of the bids received for the Central Bridge, Lowell, Mass., Sept. 28, 1882. The bridge of 3 spans, 158 ft. 7 in., center to center of masonry. Roadway, 34 ft. Two sidewalks, 8 ft. in clear:

Name and Location.	Price.	Time from date of contract.	Remarks.
Morse Bridge Co., Youngstown, O.	$51,590	5 mos.	Manly & Cooper, Belmont, fence.
Penn Bridge Wks., Beaver Falls, Pa.	53,300	5 mos.	Own fence.
Wrought Iron Bridge Co., Canton, O.	58,853	4 mos.	Manly & Cooper, Belmont, fence.
Phœnixville Bridge Works, Phœnixville, Pa.	59,580	Feb. or March, '83.	Manly & Cooper, Belmont, fence.
Boston Bridge Works, Boston, Mass.	59,600	6 to 7 mos.	Own fence.
Corrugated Metal Co., East Berlin, Conn.:			
Plan A.	60,076	May 10, '83	Pratt Truss, M. & C., Belmont, fence.
" B.	60,826	do.	do. do.
" C.	64,226	do.	do. do.
" D.	64,626	do.	do. do.
" E.	61,726	do.	Parabolic Truss, M. & C., Belmont, fence.
" F.	62,226	do.	do. do.
D. H. & C. C. Morrison, Dayton, O.	65,764	6 mos.	Own fence.
King Bridge Co., Cleveland, O.	66,600	6 mos.	do. do.
Pittsburgh Bridge Co., Pittsburgh, Pa.	66,850	May 1, '83.	do. do.
Hilton Bridge Construction Co., Albany, N. Y.	55,000	Mar. 20, '83.	do. do. Riveted bridge not called for.

AMERICAN SOCIETY OF CIVIL ENGINEERS.

The society met Wednesday, Oct. 18th, 1882, at 8 p. m., Vice-President Wm. H. Paine in the chair, John Bogart, Secretary. The death of Henrique Harris, M. Am. Soc. C. E., on Oct. 10th, was announced and the preparation of a memoir was directed.

A paper by Henry D. Blunden, M. Am. Soc. C. E., on the *Care and Maintenance of Iron Bridges* was read by the Secretary. The writer observed that while many papers and much discussion had been published on the design and construction of Bridges, there had been little or nothing on the subject of their care and maintenance after erection. Indeed, there seems a prevalent idea that once erected they will last forever with no care but an occasional coat of paint, and even that is often not attended to. A close examination during nine years past of a large number of bridges shows constant, shameful neglect. The fact is that the immediate care of bridges is generally left to men who know nothing either practically or theoretically of their design or manufacture. The single idea is to screw everything up tight and to replace all rivets without asking why a rivet drops out several times in the same place. The paper enumerated various causes of undue wear in bridges; uneven bearing of rails and ties; insufficient freedom of expansion gear often caused by accumulation of dirt; improper anchoring of fixed ends; poor masonry; uneven adjustment of laterals; uneven bearing of suspended floors; over-tightening of counters; corrosion of iron; false economy in construction of floors rendering renewals very expensive; too large joints between ends of rails.

The writer also gives a number of suggestions as to the proper care of bridges, particularly insisting upon constant inspection and frequent reports to the office of the Chief Engineer.

The paper was discussed by Messrs. C. Macdonald, S. H. Shreve, Thos. Cooper, Wm. H. Paine, J. P. Davis, W. E. Worthen, J. G. Sanderson, C. E. Emery and J. C. Campbell. In the discussion the great necessity of attention to the care of bridges in use was forcibly brought out. Instances were mentioned of the serious results of intrusting this duty to incompetent men and of the advantage found by the few corporations now taking proper measures. Reference was made to the great difficulty of adjustment in bridges with parts in cast and parts in wrought iron. A case was described in which an iron rod in contact with sulphur became seriously corroded. It was stated that the ordinary commercial suphur had an amount of sulphuric acid sufficient to cause rust, but that when properly washed it was safe. The use of sulphur or lead for joints was discussed. An ordinary misapprehension as to scale was illustrated by an instance when the actual amount of iron in the scale was found to be but one-tenth of the scale. The use of lime whitewash to protect iron was considered, and instances of its good effect were mentioned. Mr. J. C. Campbell mentioned a case where he uncovered 1,000 ft. of cast-iron water pipe and found it perfectly free from rust, it having been well whitewashed many years previously before laying. Mr. Jos. P. Davis inquired concerning the experience of members with paint for iron bridges where they were exposed to the action of locomotive smoke and steam. He had tried all kinds of paint on the Boston bridges, but had come back to red lead, which, however, was unsatisfactory.

THE HISTORY AND STATISTICS OF AMERICAN WATER-WORKS.

BY J. JAMES R. CROES, M. AM. SOC. C. E.

(*Continued from page 356.*)

CCCLXXXVIII.—DALLAS, TEX.

Dallas, Texas, in lat. 32° 40′ N., long. 96° 45′ W., on Trinity River, is on a bluff 25 to 30 ft. above high water mark.

Settled in 1841, it was incorporated as a town in 1844.

Water-works were built by Travers Daniel, for a private company, in 1876, taking the supply from a well 32 by 80 ft., sunk in coarse gravel near the river. The well is connected with the river by 500 ft. of 12-in. iron pipe. The water is lifted 100 ft. into a plate iron stand-pipe 15 ft. in diameter and 55 ft. high, by two Knowles pumps of 80 H. P.

Distribution is by 10 miles of cast-iron pipe of from 10 to 4 in. diameter, with 73 fire hydrants, 45 gates, and 500 taps. There are three meters in use. Service pipes are of wrought iron. The population in 1880 was 10,358. The daily consumption in 1881 was 145,000 gallons.

The works have been purchased by the city. They have cost $85,000, and the bonded debt is $70,000, at 6 per cent. interest. The total receipts have been $72,000. The expenses in 1881 were $5,000, and the receipts $12,000.

The works are managed by a board of three water-

commissioners, chosen by the Common Council from their own number. The Superintendent is appointed by the Commissioners for 2 years. Henry A. Hiles was the Superintendent of the company to 1882. The office is now held by A. M. Wheless.

CCCLXXXIX—CARTHAGE, MO.

Carthage, Missouri, in lat. 37° 15' N., long. 94° 30' W., is on Spring River. Settled in 1866, it was incorporated as a city in 1872.

Water-works were built for a private company in 1881–2, by John M. Slaney, taking the supply from Spring River. The water is passed through a filter of stone and gravel 25 by 50 ft. and 12 ft. deep, and is pumped by a Knowles pump of 1½ million gallons daily capacity, to a height of 170 ft. into a stand-pipe of plate iron 8 ft. in diameter and 70 ft. high, on ground 70 ft. above the city. The ordinary pressure in the mains is 40 lbs. and the fire pressure 60 lbs.

Distribution is by 7 miles of cast-iron pipe of 10 to 4 in. diameter, with 50 fire hydrants and 6 gates. The number of taps is not given. The city pays $60 per year for each hydrant. Service pipes are of wrought iron.

The population in 1880 was 4,210.

The daily consumption in 1881 was 150,000 gallons.

The capital stock of the company is $60,000. The works have cost $65,000 and the bonded debt is $50,000.

The receipts in 1881 were $7,500.

David S. Thomas is the President and Superintendent, and C. L. Bartlett the Secretary and Treasurer.

(TO BE CONTINUED.)

WESTERN SOCIETY OF ENGINEERS.

The 155th regular meeting was held at 4 P. M. Oct. 3, in the rooms of the Society. Mr. Benezette Williams was called to the chair, and Mr. Liljencrantz was appointed to act as Secretary *pro tem.* The following gentlemen were elected members: Mr. John J. McVean, Chief Engineer Detroit, Lansing & Northern Railroad, and Mr. Charles S. Pease, U. S. Civil Assistant Engineer, Council Bluffs, Ia. Mr. D. J. Miller, Engineer of the Chicago City Railway Company, read a paper on "The Chicago Cable Roads." The paper was illustrated by a number of drawings, and was subsequently discussed by the members, among whom Mr. Wright, Engineer of the North Chicago City Railway, endeavored to demonstrate that the horse railway is equally cheap, furnishes as rapid transit, is less dangerous, and gives, all considered, as much general satisfaction, when compared with the cable road.

GENERAL INTELLIGENCE.

☞ *We solicit and are always pleased to publish in these columns any items of interest that may be furnished us.*

GAS AND WATER.

MESSRS. J. A. CLOUD & CO. have secured the contract for building water-works at Randolph, N. Y. The water is taken from Cold Spring, two miles from the town; gravity system; elevation of source of supply, 180 ft.

VOTED TO BUILD WATER-WORKS.—The people of Bellefontaine, Ohio, at the last election voted in favor of building water-works at an estimated cost of $60,000. ——The gas-works are now owned by the city. The streets are all lighted out of the net earnings of the works and gas furnished to consumers at $1.50 per thousand feet.

NEW WATER-WORKS IN INDIANA.—The city of Jeffersonville is building water-works to cost $75,000 or $80,000. Grounds upon which to erect the stand-pipe and engine-house have been purchased at Port Fulton, a suburb of Jeffersonville, and the pipes for the works are being delivered upon the streets of the city.

THE town of Swampscott, Mass., has voted to take water from Lynn, Mass., and has appropriated $5,000 for pipes. The Lynn Water Board offered to furnish water for fire purposes for $106 per year and to charge the Lynn rates for connections for domestic purposes.

PULLMAN, Ill., consumes about 800,000 gallons of water daily.

SOUTH ABINGTON TO HAVE A SUPPLY OF WATER.—ABINGTON, MASS., Oct. 13.—South Abington held a largely-attended meeting to-night, William P. Corthell, Moderator, the main issue being the consideration of the report of the committee chosen in regard to protection against fire and for a water supply. After nearly two hours' discussion it was voted that the following plan be adopted, not to exceed an expenditure of $50,000: To pump the water from Hobart Pond into an iron reservoir 30 ft. in diameter and 60 ft. high, on Tillson Hill, and to lay about seven miles of pipe to carry the water through the town for the Fire Department, family and manufacturing uses; to purchase three hose carts, 1,800 ft. of hose, two Harkness extinguishers, village size, with three buildings for keeping the same. It was also voted that the present committee investigate in regard to all the legal bearings on the matter, and report at a future meeting.

THE MADISON CITY WATER-WORKS, which are being built after the plan of Chester B. Davis, and under his supervision, are approaching completion. The work was commenced about July 1st. The pipe laying was completed on the 3d inst., there being 12 miles in all, and it is now being tested. The building and machinery are nearly completed, and the regular supply for ordinary purposes will be commenced on or before Nov. 1st. The water supply is obtained by artesian well 750 ft. deep, from the Potsdam sandstone, the water flowing naturally to a level about 3 ft. above Lake Mendota. The trial well, 5 in. diameter, was tested by pumping to a daily capacity of about 500,000 gallons per day. Two 8-in. wells are to be sunk to the same depth to complete the supply, and a pipe is to be run into the lake for fire purposes, when necessary to have more water than the wells will afford. The construction of the stand-pipe, which is to be 8 ft. in diameter and 175 ft. high, will be put off until next year. The total cost of the work done this year will be over $100,000.

MORE WATER FOR WASHINGTON, D. C.—The project submitted by Major Garrett J. Lydecker, Corps of Engineers, U. S. A., to the Chief of Engineers regarding the work of extending the Washington aqueduct as provided by the act of July 15, 1882, was forwarded by General Wright to the Secretary of War for his action, and was approved on Tuesday by Secretary Lincoln. Major Lydecker explains what has been done in the way of surveys, and suggests that a tunnel from the distributing reservoir to the proposed reservoir on the heights near Sixth street will accomplish the desired results in the most substantial manner at the least cost and the shortest time. He thinks there is no doubt that the tunnel can be made through solid rock in a direct line, and its construction would be a simple piece of engineering work. The tunnel will be 21,400 feet long, requiring about 66,350 cubic yards of excavation, at a probable cost of about $500,000. The total appropriation available under the bill is $1,472,979.30, of which $599,534.55 is for the extension of the aqueduct alone. A tunnel will be preferable to a surface conduit, as it avoids complicated engineering difficulties and extensive excavations. He reccommends that the work be done by hired labor, but this is not approved by General Wright, and the question is left for future action. Trial shafts will be sunk by Major Lydecker to determine whether solid rock will be found along the whole line of the proposed tunnel. Plans for raising the Great Falls dam will be submitted hereafter.

IN your issue of Oct. 7, 1882, page 354, you give us credit for having contract for water-works at Lyons, Ohio. This is a mistake; we have a contract at Alliance Ohio.

Yours truly,

J. A. CLOUD & CO.,
18 Wall street, N. Y.

ELECTRICITY.

LIGHTING HELL GATE.—A note from Washington dated the 13th, says: At a regular meeting of the Light-house Board to-day, a report was received from the special committee on the lighting of Hell Gate by electricity, recommending Hallett's Point as the best available site for the electric light tower; also suggesting that the tower be constructed of iron, with a height of 250 ft., and to contain lights of 20,000 candle power to be displayed from sundown to sunrise. The report was adopted and it was ordered that the necessary plans and specifications for the tower and machinery be prepared at once. Proposals for the work will be advertised for as soon as the necessary papers can be prepared. It was also decided that all the machinery to be employed in this tower be duplicated, so that in case of accidents to any part of the machinery it can be immediately replaced.

THE LARGEST CABLE.—The cable which the Baltimore & Ohio Telegraph Company laid Sept. 26, across the Narrows at the entrance of New York Harbor is believed to be the largest cable made in this country. It contains seven conductors of No. 14 copper wire, insulated with kerite, and wound with galvanized iron wire. Its length is 6,500 ft., diameter 2¼ in., and weight 3,500 pounds. It was made by the Kerite Company, at Seymour, Connecticut. Telegraphic communication with the West and South has hitherto been through cables across the Hudson. The new connection is by wires across the East River Bridge, thence to Fort Hamilton, crossing the Narrows to Staten Island by the cable. A cable across the Kill von Kull will connect Staten Island with the mainland.

MOLINE, ILL., is talking of the electric light.

A NEW CABLE.—OTTAWA, Ont., Oct. 12.—Next summer the government will lay a cable under Lake Superior, connecting with the telegraph system of Ontario.

THE MIDLAND TELEPHONE CO. have established telephone exchange at Bellefontaine, O. About 100 subscribers at present and number steadily increasing. Connections have just been completed with Cincinnati, Dayton, Springfield, Xenia and other neighboring cities and towns.

STREETS, DRAINAGE, ETC.

WATERBURY SURVEY.—The sewer commissioners of Waterbury, Conn., procured plans for sewerage of the city from Eliot C. Clarke, C. E., of Boston, and Rudolph Hering, C. E., of Philadelphia. They preferred Mr. Hering's plan and recommended it for adoption. This plan, as appears from Mr. Hering's very lucid report, provides for the present discharge of the sewage into the Naugatuck and Mad rivers, with such an arrangement of the outfalls as will admit of the future interception of the sewage and its conveyance to grounds below the city adapted for purification by irrigation, when the volume of sewage shall have become sufficient to pollute the streams. The topography has been carefully studied by the engineer, with the result of recommending for economical reasons a partial separation of storm and sewage water in some localities and an entire carrying of storm water in others. As far as can be judged by a person not familiar with the localities, the reasoning in the report is sound and the conclusions justified by the reasoning. Some of the rain water can be carried off by natural channels, and it is sensibly advised that roof and yard water should be turned into the sewers and street water which carries dirt and detritus should be kept out of the sewers and put into the streams. The cost of the sewers, recommended to be constructed at once, is estimated by the commissioners at $73,330.

RIVERS AND HARBORS.

THE MISSISSIPPI LEVEES.—VICKSBURG, MISS., Oct. 16.—Work is about to be commenced on the broken levees between here and Memphis. Several contractors are in the city to-day, making large purchases of implements, and are preparing for active operations.

DAN KELEHER is employing twenty-eight men in building a wing dam in the Mississippi River, on government contract, five miles below Burlington, and at the same time he is furnishing rock for ice-breakers at the Chicago, Burlington & Quincy bridge at Burlington. The government contract amounts to $25,000.

RAILROADS.

A CERTIFICATE OF INCORPORATION REFUSED.—BOSTON, Oct. 13.—The Board of Railroad Commissioners has refused the application of the New York & Boston Inland Railroad Company for a certificate of incorporation because the capital stock has not been subscribed for by responsible persons.

THE project of the Cincinnati, Green River & Nashville Railway Company, to construct a railroad from King's Mountain, on the Cincinnati Southern, to Nashville, on the line that was surveyed and partially graded for the Cumberland & Ohio road, is taking shape, and it is expected that active operations will be begun within the next thirty days.

THE AUSTIN, MANKATO & ST. CLOUD RAILROAD.—The Austin *Transcript* gives the terms of the contract for building the Austin, Mankato & St. Cloud Railroad: "The New York Construction Company is to build the entire line of about 190 miles, between the Iowa State Line and St. Cloud, within two years from Dec. 15, 1882. The only conditions are that bonuses equal to $1,000 per mile, in the aggregate, shall be voted—or in other words, the company expect $200,000 in bonds for the entire line. The company will ask of the city of Austin $29,000, and it is expected our citizens will have a chance to vote the bonds on general election day. Propositions and papers are being prepared by Director Page, and the proper notices which the law requires will soon be posted."

WILL ISSUE $1,100,000 BONDS.—A note from Philadelphia dated the 17th, says: A proposition to issue $1,100,000 bonds was adopted at a meeting of stockholders of the Susquehanna & Delaware River Railroad today. It is also proposed to build a line 200 miles long from Harrisburg to the Delaware at Portland or Belvidere. R. B. Osborne, the engineer of the railroad, read a report in relation to the section between Slatington and Kettallar Station on the Lehigh & Lackawanna branch of the Central Railroad of New Jersey, a distance of thirteen miles. It is stated that the building of the road met with warm encouragement from the owners of slate quarries, and that the President of the Lehigh & Susquehanna Railroad had given one of the engineers of the Susquehanna & Delaware River Railroad to understand that, in the event of competition with the latter road, his company would make a traffic contract with it.

PROGRESS OF THE CANADA PACIFIC.—W. C. Van Horne, general manager of the Canadian Pacific Railroad, says there is about 1,300 miles of that road completed, and there is yet 2,850 miles to be laid. The work is advancing three and a quarter miles per day on the main line west and from Lake and a half to two miles per day on the branches. There will be 360 miles of branch road in operation this fall. To do the work of construction and to operate the line requires the help of 10,000 men. Of the force 5,300 are in the direct employment of the road, and the others are under contract. The pay of the laborers working for the road is $2 per day. Those employed by the contractors receive $2.25 per day. This force will be kept at work until Nov. 1. There has been no sickness among the men this season and all are young and hearty. A part of the laborers will probably go south this winter. The company has a contract with a number of them to return them to the boundary line free of cost.—*Exchange.*

THE MISSISSIPPI VALLEY R. R.—A special from Vicksburg, Miss., says: "Work on the Mississippi Valley Railroad south and north of here is progressing rapidly. The contractors have a force of 500 men and 90 teams working the cut through the dividing ridge between the Big Black River and Bayou Pierre. A construction train is now laying steel rails south of the Big Black River. Two engineer parties are locating the line between Baton Rouge and Port Gibson, working from each point, and the contract for the construction of this section will be let as soon as the line is located. North of Vicksburg 30 miles of the road-bed has been completed, and a large force is at work constructing a bridge over the Yazoo River."

THE Nebraska, Topeka, Iola and Memphis Railway Company has been reorganized and the following officers chosen: President, A. G. Clarke, of Chicago; Vice-President, H. M. Clarke, of Chicago; Secretary, General A. Boweins, of Iola, Kan.; General Solicitor, J. H. Richards, of Iola, Kan.; Directors—T. W. Giles, E. C. Deveraux, A. S. Johnson, Topeka; C. H. Martin, Girard, Kan.; B. E. Clarke, W. H. Clarke, S. W. Ransom, of Chicago, and all the officers named above. A contract was let to B. E. Clarke & Co., of Chicago, to build 100 miles of the road from Iola to Topeka,

which will complete the line from Girard here. The work of construction, it is said, is to commence at once, and will be pushed vigorously, with the expectation of having the road completed to Topeka by October 1, 1883.

PROGRESS IN MEXICO.—We have received items as follows from the City of Mexico: Several works of public improvement were formally begun in this city and in the interior on the 16th.——The railroad from Puebla to San Martin, Texmelucan, was opened to traffic amid the great rejoicing of the people of the adjacent country.——Traffic was begun on the Mexican Central Railway from El Paso through to Chihuahua, and the line on the Merida and Calkini Railroad was opened as far as the "hacienda," of Chansinkin, and on the same day work was begun on the construction of a street railroad in San Juan del Rio.——The railway progress here at present is remarkable.——A telegram received lately announces that the Altata Railroad will be completed to Culiacan by the 16th of next month.——It is stated that the railroad from Campeche to Lerma will also be completed by the end of October.——Work is being pushed with great energy on the National Interoceanic Railroad—the narrow-gauge line to connect this city with Alvarado on the Gulf and Acapulco on the Pacific. An excursion party composed of 400 persons celebrated lately the completion of the Mexican National Railroad to Monterey by making a trip to Nuevo Laredo.——The following work is reported on the Irolo Railroad, which is ultimately to extend through the State of Puebla and form connections that will constitute a new line to Vera Cruz: 21 kilometers from this city to Reyes, 21 kilometers from Reyes to Texcoco and 18 kilometers from Texcoco to Irolo completed; 15 kilometers are also completed beyond Irolo, and work is active on the next 5 kilometers. The line from Irolo to Tepetlaxtoc is also under construction.——The Department of Public Works has extended the time for making the surveys of the railroad from San Luis Potosi to Aguascalientes six months. On the railroad from Tampico to San Luis Potosi 165 kilometers of line have been located, 95 kilometers cleared of undergrowth and 48 kilometers completed.——There is much activity displayed on the Guanajuato branch of the Mexican Central, and it is expected that it will be opened for traffic about the 20th of next month.——A train conveying Messrs. Hinchman, Buchanan and Ibarrola went out on the Mexican National Railroad on the 13th as far as Puerto Medina, 126 kilometers from this city. An immense crowd, composed of the residents of the surrounding towns, had assembled to greet the arrival of the train, and great enthusiasm was manifested. The citizens of Tlapujahua presented a Mexican flag to the company: bearing the following inscriptions. On the green stripe, "Viva el progreso;" on the white: "Tlapujahua and vicinity congratulate the company on reaching Puerto de Medina with their engine," and on the red: "Tlapujahua, district of Maravatio, to the Company Sullivan, in honor of its railroad progress. September 13, 1882." The road is reported to be solidly built and in good condition.——The regulations proposed by the government for the management of railroads have become a matter of deep interest to these enterprises. The code, which contains no less than 391 articles, deals with almost everything that concerns a railroad, from the right of way to the issue of baggage checks. They say that the rules are based on those enforced by a French company, which framed them for the guidance of its own staff, not caring whether they were adapted for use elsewhere.

THE ST. PAUL, EASTERN & GRAND TRUNK RAILWAY.—At the annual meeting of the St. Paul, Eastern and Grand Trunk Railway, held in Chippewa Falls, Wis., the reports of the President and Superintendent were submitted. Twenty miles are in progress of construction, and the first ten miles from Oconto, a connection with the Wisconsin & Michigan road, is ready for the rail. President Pound reported the purchase and shipments of the first 1,000 tons of rail and all material for construction. Track-laying will commence about the 20th. A new board of directors was elected.

THE FOREST CITY SOUTHERN RAILWAY OF IOWA has changed its name to Chicago, Iowa & Dakota Railway Company. The road is now being built from Gifford, in Hardin County, to Forest City, in Winnebago County, eighty miles. Track is already laid to Eldora.

PASSENGER TRAFFIC.—It is held by well-informed railroad men that more people are handled daily at the Kansas City Union depot than at any other in America, and the caterer's rent, which has been in the neighborhood of $6,500 per year, has been raised to $20,000.

A CABLE ROAD.—There is a pending offer to construct a cable line for street cars in Columbus, Ind., provided the city will grant a satisfactory charter.

PROGRESS ON THE OREGON SHORT LINE.—The main line of the Oregon Short Line is now built 26 miles from the falls of Snake River, and is within 65 miles of Junction City. Owing to the scarcity of ties the main line will not be able to reach the junction this year, and probably will not build much farther than they now are. From the junction to the falls the distance is 93 miles, and the road is almost an air line. The grading is nearly completed to the junction, and between there and Little Wood River on the branch road considerable work has been done, with the exception of about three miles. The bridge over Little Wood River is very nearly completed, and a great amount of heavy work has been done, in fact, more than could reasonably be expected, owing to the nature of the country.

ROAD COMPLETED.—On Monday last the final spike was driven and the last rail was laid on the Leavenworth, Topeka & Southwestern Railway, on its line between Leavenworth and Meridan, where connections are made with the main line of the Atchison, Topeka & Santa Fe road. With the completion of the new line Leavenworth is just 12 miles nearer Topeka by rail than heretofore, the distance by Lawrence being 69 miles, while by the new line it is only 57 miles.

PRICES OF STEEL RAILS IN EUROPE.—From the *Ironmonger* of London we take the following: The following tenders were recently sent in to the Roumanian Minister of Public Works for the supply of 16,500 tons of steel rails: Bolckow, Vaughan & Co., Eston, 159f. 37c. per ton; Cockerill, Belgium, 162f. 55c.; Bochum Verein, Germany, 162f. 48c.; Gute Hoffnungs Hutte, Germany, 183f. 90c.; Krupp, Germany, 174f. 60c.; Aron Hirsch, Austria, 185f.; Moss Bay Hematite Iron, &c., Company, 173f. 50c.: Union Dortmund, 162f. 60c. Bolckow, Vaughan & Co.'s tender was thus distinctly below those of the other competitors, and the *Curieral Financiar*, in noting the tenders, adds that not only are the English rails the cheapest, but that in quality also they surpass those of any other country.

TUNNELS.

HUDSON RIVER TUNNEL.—Work on the Hudson River Tunnel is being steadily pushed forward, and by Nov. 1 the large air compressor now building for the tunnel by the Clayton Steam Pump Works of Brooklyn, N. Y. (three of whose compressors have been used since the commencement of the tunnel), will be placed in position and working. This air compressor is of the Clayton Improved Duplex pattern, having two 22-in. diameter steam cylinders, two 24-in. diameter air cylinders and 30 in. stroke. It is 20 ft. in length, 10 ft. in width; weighs 25 tons; and its working capacity is 3,750,000 cubic feet of air per 24 hours.

CANALS.

THE French engineer, M. Laurent, has received the permission of the Austrian government to make a canal joining the small Galician River, the Sau, with the Dniester, which will complete the water communication between Dantzig and Odessa. The undertaking is a private enterprise.

BRIDGES.

RAILROAD BRIDGE REBUILT.—The Mexican National Railroad Company completed the reconstruction of its bridge across the Rio Grande at Laredo on the 11th, thus restoring rail communication between the republics, which was broken a few weeks ago by high water. The bridge has 20 spans, each 30 ft. long. The International & Great Northern road, whose bridge was also swept away by the same freshet, has not yet begun to rebuild.

BRIDGES FINISHED.—The 6 of the 11 new bridges the Cincinnati, Indianapolis, St. Louis & Chicago Company is building between Sunman and Lawrenceburgh Junction, have been completed.

BUILDING.

THE NEW HEAD-QUARTERS of the Baltimore & Ohio at the corner of Baltimore and Calvert streets, in Baltimore, will be occupied next month. The ground is the most costly of any of its area in Baltimore, but its central location warranted the expenditure. The building has a frontage of 102 ft. 6 in. on Baltimore street and 104 ft. 4 in. on Calvert street, and is without doubt one of the finest structures for its purpose in the world. The road, by the way, has just made a semi-annual dividend of 5 per cent. on the stock of its main stem and Washington branch.

NO BIDS RECEIVED.—The Police Commissioners of this city obtained an appropriation of $60,000 to build a new police station and advertised for bids, but none were received as it was thought the foundations alone would consume the entire amount. The Board now asks for $40,000 additional.

PLATTEVILLE, WIS., is to have a new city hall.

CONTRACTS LET.

JAY GOULD'S NEW YACHT.—PHILADELPHIA, Oct. 18. The contract for building a steam yacht for Jay Gould was this afternoon awarded to Cramp & Sons, of this city. It will be constructed of iron and steel, and will have steel boilers. It will be 210 ft. long, 27 ft. beam, and 16 ft. deep, and will have 1,500 indicated horse-power. The vessel will be ready for sea early in the spring.

STONE CONTRACT COMPLETED.—A contract is now being completed at the Montello, Wis., quarry for $100,000 worth of stone for Chicago parties to be used for paving the streets. The stone is got out in pieces ten inches long and about five inches square, twenty five of them making a square yard when laid. The expense of this block delivered at Chicago is about $4.25 per yard.

CAR CONTRACT MADE.—Mr. C. C. Waite, Vice-President and General Manager of the Cincinnati, Hamilton & Dayton, has contracted with the Terre Haute Car Works for 100 new flat cars.

GOVERNMENT CONTRACT LET.—Bids were opened in the office of the Supervising Architect of the Treasury on the 12th, for iron railings for approaches at the post-office and court-house building and for floor lights at Philadelphia as follows: Samuel J. Creswell, $5,512-80; Manley & Cooper, $5,940; Bartlett, Hayward & Co., $6,065; J. S. Stevens, $5,995; J. S. Thorn, $5,700; Phœnix Iron Company, $5,854. The contract will be awarded to Samuel J. Creswell.

At the last meeting of the trustees of Hyde Park, Ills., the superintendent of public works was instructed to prepare plans for a bridge across the Calumet River at Ninety-second street. Bids for finishing the water-works tunnel were opened. They ranged from $52,000 to $69,000. Dolese & Shepard were awarded the contract for grading and macadamizing South-Chicago avenue from Stony Island avenue to South Park avenue for $31,020.

MISCELLANEOUS.

Leadville now produces one-third of the lead made in the United States.

Twenty years ago it required five tons of coal to make a ton of iron rails. Now a ton of steel rail may be produced from the ore with half that amount of coal.

New York doctors have declared against flats and apartment houses on the ground of health.

Many prominent New York society ladies are ill of malaria contracted at summer resorts.

ON THE CONSTRUCTION OF THE SECOND AVENUE LINE OF THE METROPOLITAN ELEVATED RAILWAY OF NEW YORK.

(*Concluded from page 365.*)

makes the surface of the paint solid and of resinous appearance, possessing toughness and elasticity. Linseed oil does not crack or blister, by reason of the expansion and contraction of the iron with variation of temperature. Another important characteristic is its expansion while drying, which peculiarly adapts it to iron surfaces. The Metropolitan Elevated Railway Company spent no small amount of money in experimenting with various classes, kinds and colors of paint, before arriving at a final conclusion; their labors at last culminated in the selection of a metallic paint for the first coat, and a white lead paint for the second and last coat, both paints to be mixed with the best boiled linseed oil, and enough turpentine to make the paint cover well and facilitate its drying. The following formulæ were therefore adopted and adhered to:

(1.) METALLIC PAINT.
9 parts of boiled linseed oil,
1 part of turpentine.
7½ pounds of "metallic" (ground iron ore).
Made one mixed gallon (3.79 l) of paint, and covered about 256 square feet (23.78 sq. m.).

(2.) WHITE LEAD PAINT, OLIVE COLOR.

325 pounds	(147.42 kg.)	white lead.
175 "	(79.38 ")	white lime.
75 "	(34.02 ")	French ochre.
3 "	(1.361 ")	Prussian blue.
1 pound	(.454 ")	burnt umber.
21 galls.	(79.50 l.)	boiled linseed oil.
1½ "	(5.678 l.)	turpentine.
1 "	(3.79 l.)	liquid drier.

Made 751 pounds (340.64 kg.) or 18 gallons (68.13 l.) of mixed paint, and covered about 512 square feet (47.56 sq. m.).

The iron work was first thoroughly cleaned, rough spots scraped, and such spots, together with all new rivets or other raw details, were "touched up" with one coat of metallic paint.

All the seams in top and bottom chords, gaps at brace joints, and all other cracks or seams needing it, were filled solid with linseed oil putty. The top surface of the top chords was then given one coat of metallic paint. The strap-iron, clips, fish-plates and under side of cross-ties, steel rails, and guard timbers, were painted one coat of same before adjustment. All cracks, joints, sun checks, etc., in the timber, were filled with putty prior to painting with metallic paint and again before using the white lead color.

The track superstructure received two coats of metallic paint. All track work being finished and the whole structure complete, the final covering of white lead paint was laid on with great care, under close inspection, and has proved, so far, to be the desideratum for iron surface painting. The actual cost of painting the structure, including the station girders, but not their buildings, with all the details of scraping, cleaning, puttying, together with all the materials and labor was $1.50 per lineal foot.

The labor account was $36\frac{1}{10}$ per cent. of the total cost.

While the material account was $63\frac{9}{10}$ per cent. of the total cost.

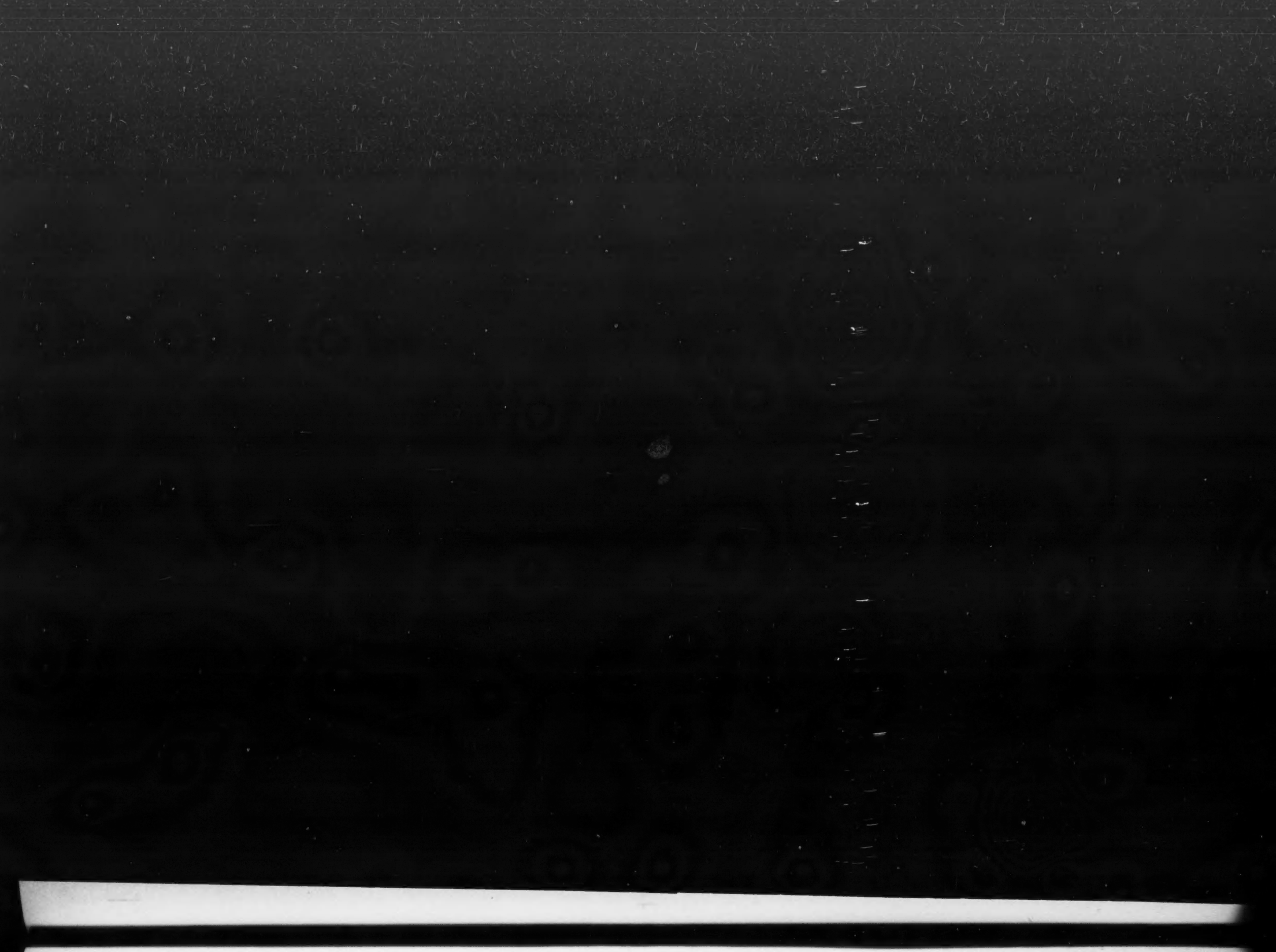
APPENDIX.

Form of estimate sheet of special street pier, built January, 1881, showing the exact construction, character of material in excavation, quantities, contract prices paid, and the total cost of the pier as ready for the column at connection with Harlem River Bridge, north end of Eighth avenue. (See Fig. 10.)

Nature of bottom, silt.
Bottom stones set, 2 (7′×3′×6″).
Bolts, 4—10′ 4″=472 lbs.
Washers, 4=108 lbs.
Base set, 1=3,200 lbs.
Refilling (62.59+73.11) — (13.49+16.92+22.67)=82.62 cu. yds.

EXCAVATION:
Earth, 13′×13′×10′=62.59 cu. yds.
Loose rock, 13′×13′×11′.68=73.11 cu. yds.
Pit work, 13′×13′×12′.93=80.93 cu. yds.
Piling, 16 — 50′=800 lin. ft.
Capping, 4 — 9″×6″×12″, 18 — 9″×6″×6″=702 ft., B. M.
Concrete, 12′×12′×4′.25=83.46 cu. ft. Grillage=19.58 cu. yds.

BRICKWORK:
Pier, 4′ 6″ sq. ×8′ 0″ sq. ×9′.083 — 21 cu. ft. (bottom stones) =12.71 cu. yds.
Sub-pier, 8′×8′×7′.14=16.92 cu. yds.

ESTIMATE OF WORK DONE AND MATERIALS FURNISHED BY M. TIERNEY, CONTRACTOR.

QUANTITIES.	ITEMS.	AMOUNT.	REMARKS.
62.59 cu. yds.	Earth excavation @ $1.50	$93.89	The iron and bottom stones were furnished by the company.
73.11 " "	Loose rock excavation @ $3.00	219.33	
80.93 " "	Pitwork @ $2.00	161.86	
800.—lin. ft.	Piling, @ $0.30	240.00	
702.—ft. B.M.	Capping @ $35.00 per M.	24.57	
19.58 cu. yds.	Concrete @ $5.00	97.90	
29.63 " "	Brickwork @ $9.00	266.67	
2	Bottom stones @ $2.00	4.00	
1	Base set	4.00	
82.62 cu. yds.	Refilling @ $0.10	8.26	
	Total	$1,120.48